# MECHANICAL ENGINEERING

*Published by The American Society of Mechanical Engineers*

VOLUME 61 NUMBER 10

## *Contents for October, 1939*

DESIGN OF UNION PACIFIC STEAM-ELECTRIC LOCOMOTIVE—I . . . *A. J. Woodward, B. S. Cain* 709

ROUTING NIGHTMARES OF WATER CONDITIONING . . . . . *R. E. Hall, E. P. Partridge, T. H. Daugherty* 715

LABOR PROBLEMS OF BRANCH-PLANT MANAGEMENT . . . . . *A. R. Heron* 722

CONTROL EQUIPMENT FOR HIGH-PRESSURE OIL AND GAS WELLS . . . *Herbert Allen* 725

PHOTOGRAPHIC STUDY OF STEAM-BOILER FURNACES IN OPERATION . . . . . *A. A. Markson, W. H. Dargan* 729

TECHNICAL MUSEUMS IN SOVIET RUSSIA . . . . . *H. P. Spratt* 735

THE NATIONAL LABOR RELATIONS ACT . . . . . *E. R. Livernash* 740

THE ENGINEER IN PUBLIC SERVICE . . . . . *J. M. Byrne, Jr.* 742

THE A.S.M.E. TODAY—I . . . . . 745

EDITORIAL . . . . . 707

BRIEFING THE RECORD . . . . . 748

A.S.M.E. NEWS . . . . . 762

LETTERS AND COMMENT . . . . . 755

REVIEWS OF BOOKS . . . . . 759

INDEX TO ADVERTISERS . . . . . 46

OFFICERS OF THE SOCIETY:

A. G. CHRISTIE, *President*

W. D. ENNIS, *Treasurer* C. E. DAVIES, *Secretary*

PUBLICATION STAFF:

GEORGE A. STETSON, *Editor* FREDERICK LASK, *Advertising Mgr.*

COMMITTEE ON PUBLICATIONS:

G. F. BATEMAN, *Chairman*

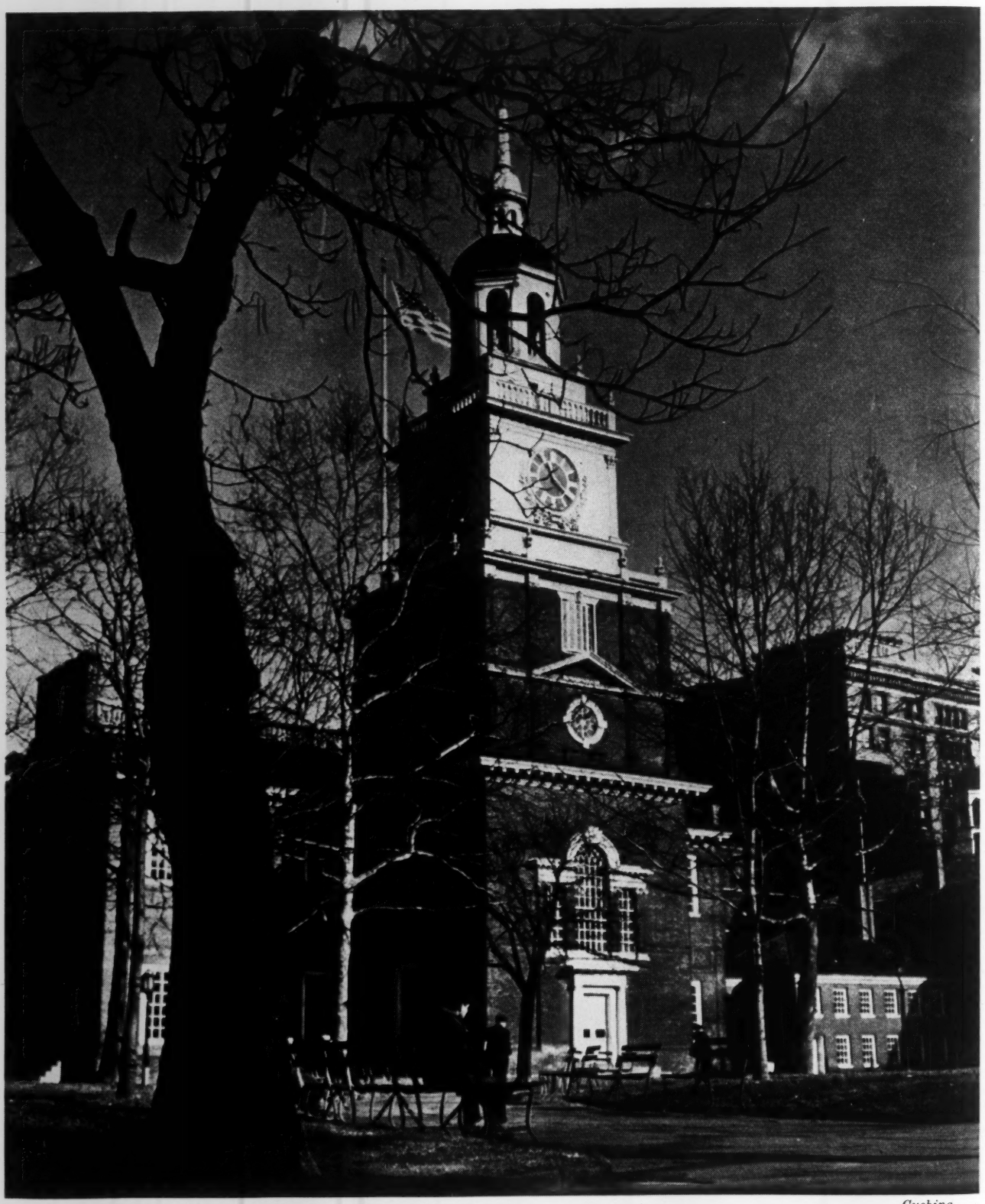
C. B. PECK F. L. BRADLEY

COLEMAN SELLERS, 3D C. R. SODERBERG

ADVISORY MEMBERS OF THE COMMITTEE ON PUBLICATIONS:

W. L. DUDLEY, SEATTLE, WASH. A. N. GODDARD, DETROIT, MICH. E. J. KATES, NEW YORK, N. Y. L. S. MARKS, CAMBRIDGE, MASS. J. M. TODD, NEW ORLEANS, LA. Junior Members, A. E. BLIRER, EDGEWATER, N. J., AND H. B. FERNALD, JR., NEW YORK, N. Y.

Published monthly by The American Society of Mechanical Engineers. Publication office at 20th and Northampton Streets, Easton, Pa. Editorial and Advertising departments at the headquarters of the Society, 29 West Thirty-Ninth Street, New York, N. Y. Cable address, "Dynamic," New York. Price 60 cents a copy, $5.00 a year; to members and affiliates, 50 cents a copy, $4.00 a year. Postage to Canada, 75 cents additional, to foreign countries, $1.50 additional. Changes of address must be received at Society headquarters two weeks before they are to be effective on the mailing list. Please send old as well as new address. . . . By-Law: The Society shall not be responsible for statements or opinions advanced in papers or . . . printed in its publications (B13, Par. 4). . . . Entered as second-class matter at the Post Office at Easton, Pa., under the Act of March 3, 1879. . . . Acceptance for mailing at special rate of postage provided for in section 1103, Act of October 3, 1917, authorized on January 17, 1921. . . . Copyrighted, 1939, by The American Society of Mechanical Engineers. Member of the Audit Bureau of Circulations.



Cushing

*Independence Hall, Philadelphia, Pa.*

(*Breaking an old tradition, The American Society of Mechanical Engineers holds its Sixtieth Annual Meeting in Philadelphia, Pa., Dec. 4–8, 1939, instead of New York.* *For announcement of the Meeting see page 762*)

VOLUME 61
No. 10

# MECHANICAL ENGINEERING

OCTOBER
1939

GEORGE A. STETSON, *Editor*

## *A.S.M.E. Today*

NEXT April The American Society of Mechanical Engineers will be sixty years old. The anniversary has seemed an appropriate occasion to call attention to the Society, as it exists and functions today, in a series of articles begun in this issue. As the series will run throughout the remainder of the current calendar year and well into next year, an opportunity is provided to cover many of the more important elements of Society organization and function without dumping all of them on the reader's desk at one time.

It is possible that questions may arise over points in the articles that are not adequately explained, or that omissions may occur in the selection of the material to be presented. Readers are urged to call attention to such deficiencies or omissions that seem important to them, first for the sake of the record, which is intended to be authoritative, and second to uncover members' views on Society activities. Constructive comment should make for better understanding and be helpful to committees and officers in charge of various phases of Society work.

## *"Light, More Light"*

ONE remembers reading in the papers statements to the effect that coffee does not cause sleeplessness, and that ragweed does not affect hayfever sufferers. If you are immune to the effects of both these weeds you are likely to brand the statements as academic pronouncements, but if you have vainly counted sheep after a Java jag or if you are sneezing your head off, you see red; neither the statements nor your interest in them is academic.

Such are likely to be the extreme views of those who read what Mr. Livernash reports in this month's issue of the opinions of Prof. Robert R. R. Brooks, whose book, "Unions of Their Own Choosing," he reviews. One gets the impression that Professor Brooks finds little fault with the Wagner Act and its administration, and that he has ready answers for those who do.

These opinions, particularly when their source is considered, seem manifestly academic, and, if we go along with Mr. Livernash's estimate, they are also biased. But even if they are both academic and biased, it may be helpful to read them because the interest of engineers is so commonly on the side of the employer, and his professional viewpoint is so remote from that of the trade-union member or organizer, that he owes it to his intellectual honesty to hear both sides of an argument. Moreover, most mechanical engineers, as has been pointed out time and again in these columns, occupy a position midway between that of entrepreneur and employee, even though he may in truth be either, because of his function as industrial administrator. After all, it's his job to make the industrial machine work, both technically and humanly, and for this an understanding of human as well as technical problems is required.

The very practical consideration that the Wagner Act is the law of the land sharpens the spur of this necessity, as Mr. Heron wisely points out in another article on labor problems of the branch plant, also in this issue. None of these facts, however, compels blind acquiescence on the part of the engineer to any status quo, whether of technology or human relationships. Laws are in a state of flux just as much as any of man's affairs, and even though legislators have so far been unable to amend the Wagner Act, it would be folly to assume that changes in it will never be made. The best service engineers can give is in interposing between the heat of partisan argument and the cold logic of academic views the light of honest experience and mutual understanding. Mr. Heron touches hopefully on this point when he suggests, as has been suggested many times, the community of interest of employer and employee that should exist in a more perfect society than ours now is, and he mentions some of the activities to which one hopes labor unions may some day devote their major attention.

Attainment of the desired cooperation in a world which seems intent on setting up and magnifying class consciousness is difficult; but one ventures to predict that the greatest progress toward it will be made by intelligent engineers in their capacity as administrators of industrial enterprises. Such progress will vindicate those who now hold that the engineer's function exceeds that of technician and will do much to erase the stigma now placed upon the engineer by the unthinking public as a disrupter of economic stability and creator of technological employment.

## *Ford and Watt*

ON JUNE 9, at the spring meeting of the Institution of Mechanical Engineers, in London, and in the presence of His Excellency the American Ambassador, the Hon. Joseph P. Kennedy, the 1939 award of the James Watt International Medal to Henry Ford, member

A.S.M.E., was announced, and the portrait of James Watt by C. F. von Breda, recently acquired by the Institution, was unveiled.

The joining of the names of Watt and Ford through the award of the medal does honor to both. Differences of historical environment, of personality, and of achievement characterize this union, but its spiritual ties are significant. One lived at the beginning of that important epoch spoken of as the industrial revolution; the other personifies the present-day status of the consequences of that revolution. Watt spent his latter years amid the ferment of Napoleonic wars and the high hopes of new social and political orders. Today, the world experiences another such ferment and looks forward to a revitalization of those orders. Men who become cynical and depressed by considering these similarities of the times of Watt and Ford would do better to concentrate on the differences.

Not the least of these differences springs from conditions which both Watt and Ford helped to bring about. Both have multiplied the means of production of wealth; both have assisted in freeing men from the slavery of labor and the restrictions of natural environment. With political dynasties and boundaries neither was directly concerned, yet both have influenced hugely the pattern and attainment of social and economic progress. The ends they both have served seem today to be the most certain to remove in some future epoch the causes of economic and social unrest that result in war, even if they add new problems with which the world must grapple. Each in his own way has aided in dispelling some of the gloom of scarcity cast by the doctrine of Watt's contemporary Malthus. Those who follow and emulate them may succeed through applied science in completely ridding the world not only of that scarcity but of many other cancerous social and economic evils. For the world, which has followed many false gleams, has no truer light to mark its future path than that which science sheds.

## *Youth at Rutgers*

THE world appears to be entering a period in which it will desperately need its young men and in which it will destroy many of them. The tragic days of twenty-five years ago are being repeated. In a considerable number of countries young men are under arms or are engaged in work that produces neither wealth nor happiness. Instead of satisfying one another's wants they are engaged in destruction, following the cessation of which will come the hectic bursts of inflation and the dreary years of economic depression, for such is the cycle of men's destinies. In Germany, where for some time, it has been reported, even scientific research has been controlled to direct it toward immediate and specific objectives, all but five of twenty universities are said to be closed. Youth is being badly served.

Against this lugubrious background the panel discussion of the present problems of young college men in industry, held at Rutgers University in September and reported on page 769 of this issue, seems unreal. However it is typical of the spirit of youth itself that such a meeting was held in the shadow of war, for it makes the essential destructiveness of war seem unreal and discloses the tenacious hopes and constant strivings that keep men alive and civilization on the upward march. Junior members of the A.S.M.E. Metropolitan section played an important part in the planning and conduct of the Rutgers discussion.

What the young men complained of will surprise no one—the difficulty of adjustment to the problems and disciplines of earning a living, salaries, company policies, indifference, incompetence, and hostility of bosses, lack of recognition. These are familiar enough. Many an older man, contrasting present-day conditions with those that prevailed in his own youth, will ask himself what there is to grumble about today. And he will be wrong; his own grumbling helped make conditions better for his son, and the son, with his companions, will outstrip the fathers.

But it wasn't all grumbling at Rutgers. The young men dragged into the open facts that made some of their employers think, and, perhaps, will result in improved conditions for the next batch of recruits for industry. Moreover, they laid stress on the value of self-analysis, of understanding human relationships, of better preparation and continued education, on making the most of themselves, and on advancing their own personal interests by such means as taking part in professional society activities and writing and discussing technical papers.

A country is fortunate whose young men discuss their handicaps and short-comings and devise ways of overcoming them. The attitude of mind that makes this sane self-analysis of personal problems is an asset in the solution of community and national problems. It may lead to critical and constructive examination of human objectives and means of attaining them. It will lead to a more general adoption of the methods of science and engineering, which, applied to the problems of human society, offer the rational, the constructive, the benign means of solution. In an engineering society this attitude must be encouraged, for it is on indication of strength and progress.

## *Charles M. Schwab*

THE breed of men in the steel industry represented by Charles M. Schwab entered it before it had become the highly mechanized and almost automatic process it now is. Strong backs and arms made up for this deficiency; but the steel masters themselves, many of whom had borne the burden of this heavy work as young men, accepted and encouraged those who applied science and engineering to one of the world's oldest industries. Mr. Schwab rose to a high position in this industry. He saw and assisted in the amazing progress it has made in recent decades. He will be remembered as a man with a dynamic and engaging personality, as well as a captain of industry, and in The American Society of Mechanical Engineers, as one of its presidents.

FIG. 1 UNION PACIFIC STEAM-ELECTRIC LOCOMOTIVE—ONE 2500-HP UNIT

# *Design of the* UNION PACIFIC STEAM-ELECTRIC LOCOMOTIVE—I

By A. J. WOODWARD and B. S. CAIN

GENERAL ELECTRIC COMPANY, ERIE, PA.

INCREASE in speed of trains on the American railroads has brought about requirements that are radically changing the kinds of locomotives which are economical to operate. An appreciable proportion of the long-distance, high-speed trains today are hauled by modern locomotives with the advantages of (1) high availability and reliability, (2) ability to run long distances with short stops, (3) uniform balanced drive and moderate axle loading which increase safety and decrease track maintenance, (4) low fuel cost, and (5) negligible water consumption in districts where good water is hard to obtain.

As the size and power of locomotives increased, it was natural that the power plant should be examined to see what type might be preferable. The high-pressure steam turbine has been developed in stationary practice to a point where it offers real advantages, and light compact steam generators have reached the stage of development where they can be used practically within the limits of a locomotive. A steam-electric locomotive with balanced rotating parts will avoid the maintenance inherent in a comparatively high-speed reciprocating prime mover. A number of steam-turbine locomotives of various kinds have been built in Europe, but all have been essentially adaptations of turbine drive to fairly conventional steam locomotives. The development of the "steamotive" power plant by the General Electric Company, Babcock & Wilcox Company, and Bailey Meter Company, offered a possibility of producing a locomotive designed throughout to take full advantage of the advances in steam-power-plant engineering.

In 1936 the Union Pacific Railroad and the General Electric Company started the design and construction of a 5000-hp double-unit steam-electric locomotive, using steamotive power plants similar to those with which experience had already been obtained in stationary service and mechanical construction and electric drive based on successful electric-locomotive practice.

## SERVICE

The locomotive was designed to haul a train of 1000 trailing tons from Chicago to the Pacific Coast according to the 1936 schedule of the *Challenger*, that is, 2200 miles in 56 hours. It was also designed so that either half of the locomotive could be operated as a separate 2500-hp unit to haul a (lightweight) train of 500 trailing tons from Chicago to Denver according to the 1936 schedule of the *City of Denver*, that is, 1000 miles in 16 hours. In order to handle trains at speeds in excess of 90 mph on level track and approximately 22 mph on 2.2 per cent grades, a prime-mover output of 5000 hp was made available for traction. Alternating-current power was also supplied from either unit for air-conditioning and other services. Train heating steam was also required from each unit.

The weight of the locomotive was within the capacity of two 2-C-C-2 (or 4664) units, this arrangement of running gear having proved satisfactory for high-speed electric operation. The total weight of 708,000 lb on drivers was more than adequate for any tractive effort required by the service.

A normal maximum speed of 110 mph is provided but the equipment is actually designed for 125 mph to allow for increased speed if it should be required.

Climatic conditions on the Union Pacific system are quite severe. The temperature varies from —40 F to 115 F. The elevation varies from sea level to over 7000 ft and dust is a serious problem on certain sections. There are also regions in which good water is difficult to obtain.

## GENERAL DESIGN

The condensing feature of this locomotive avoids the use of any large amount of water and permits the adoption of a high-pressure, high-temperature steam generator which operates on distilled water. The condenser therefore operates in a closed steam system in which distilled water is recirculated so that the

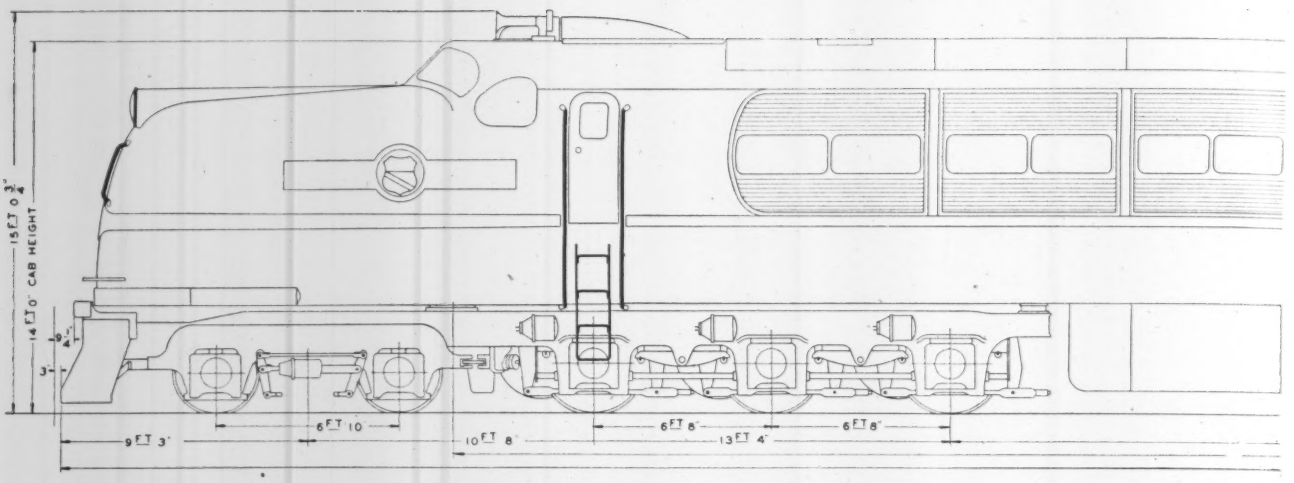



FIG. 2 DIMENSIONED OUTLINE

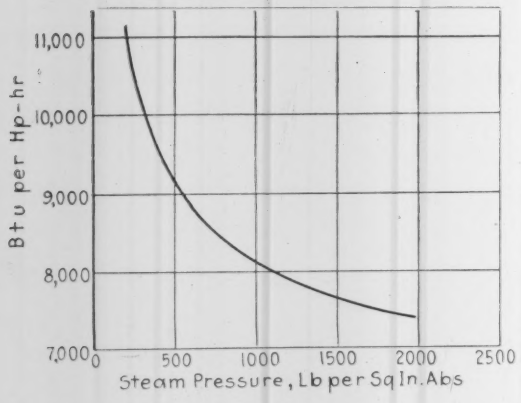



FIG. 3 THEORETICAL FUEL RATE VS. STEAM PRESSURE
(Rankine cycle with 920 F inlet and 14.7 psi abs exhaust.)

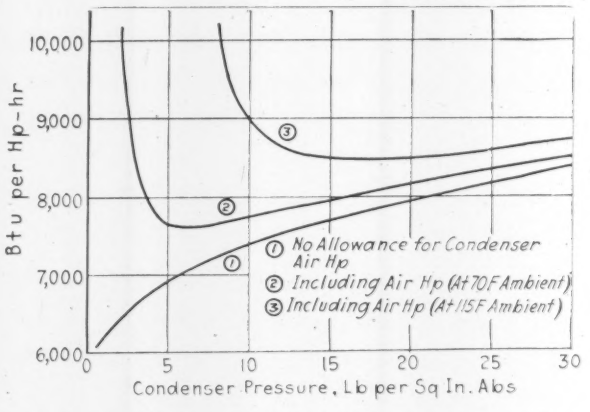



FIG. 4 THEORETICAL FUEL RATE VS. CONDENSER PRESSURE
(Rankine cycle, with and without air condenser, 1500 psi, 920 F steam.)

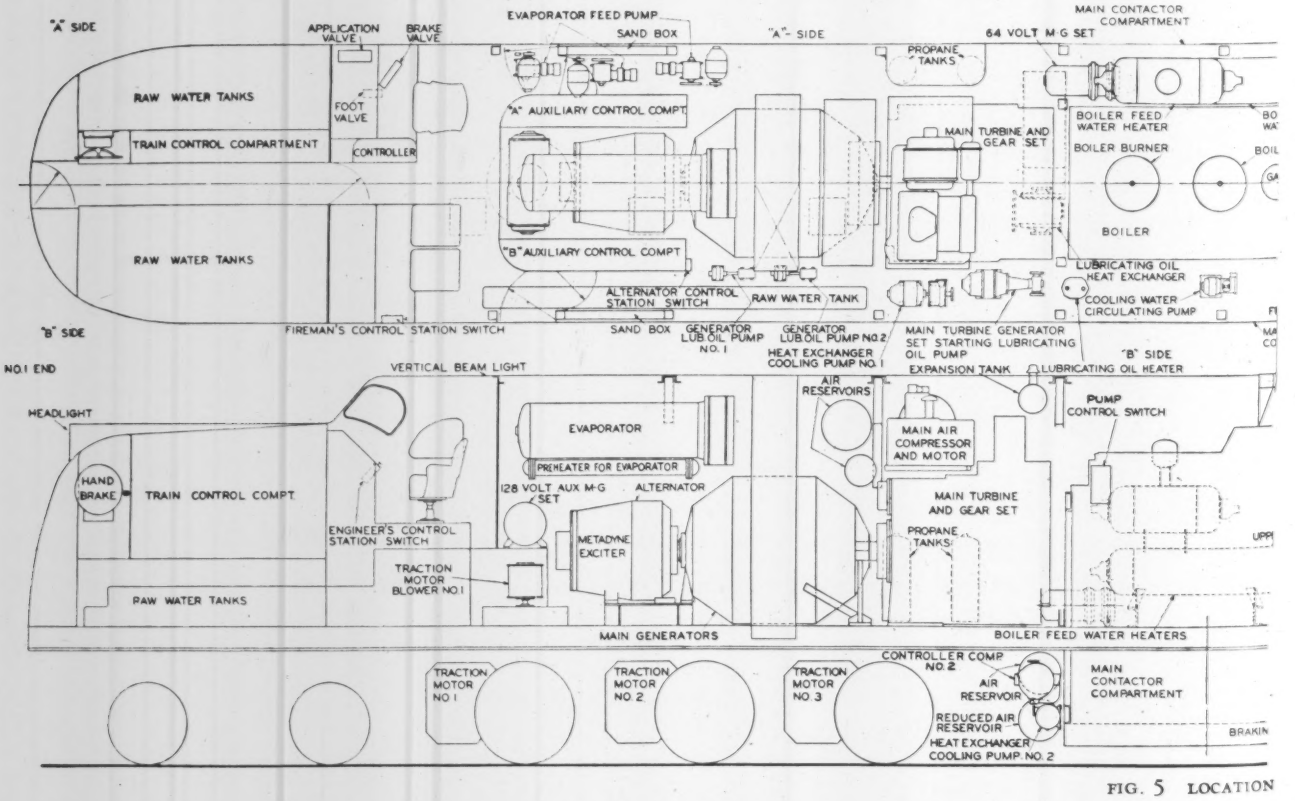
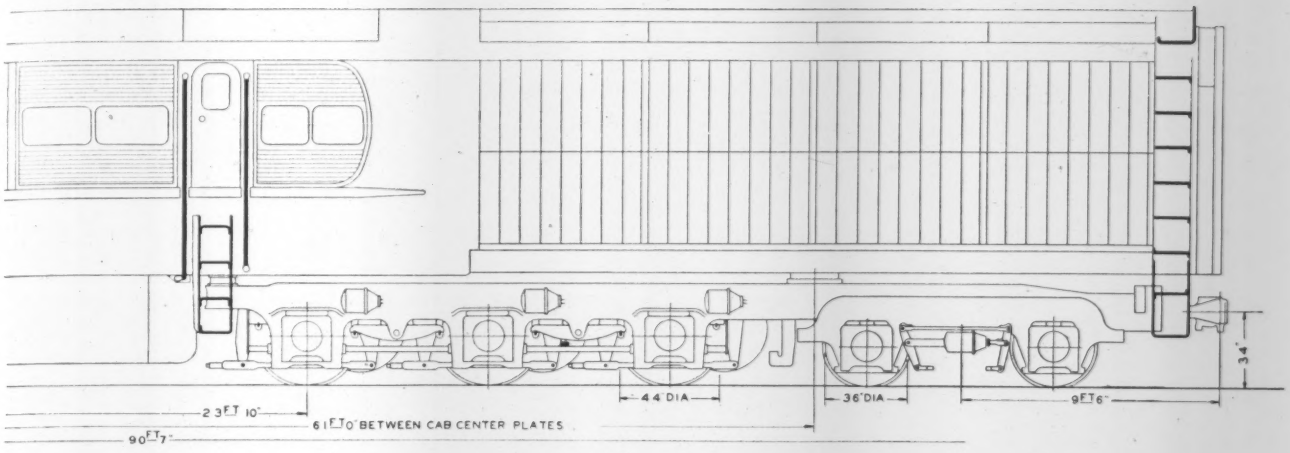



FIG. 5 LOCATION




OF ONE 2500-HP UNIT

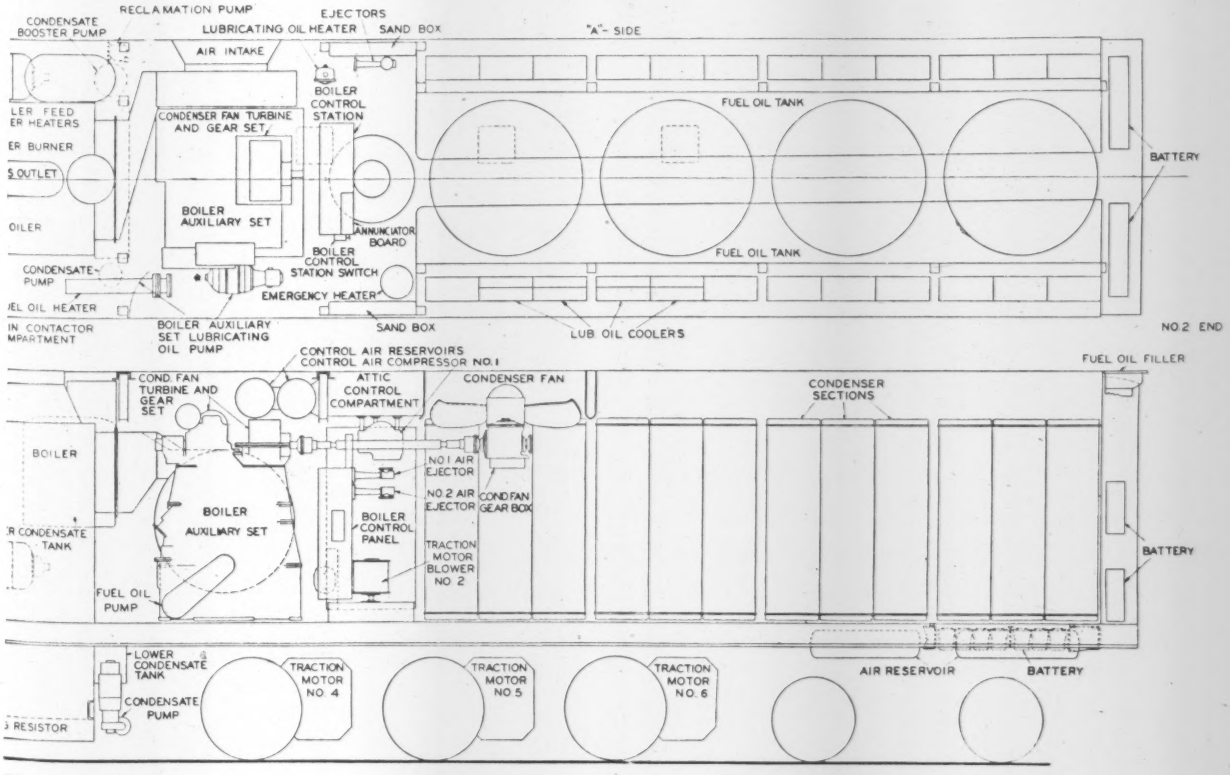
transportation and handling of large quantities of raw water are avoided. In stationary or marine practice condensers are designed to give a high vacuum to obtain high thermal efficiency. This is not practicable on a mobile installation because of the large size of the condenser and exhaust lines.

In order to illustrate the general effect of boiler and condenser pressure on the locomotive design, Fig. 3 shows the theoretical fuel rate for different steam pressures, assuming 920 F steam temperature and atmospheric exhaust (14.7 psi abs). With increase in steam pressure the theoretical fuel rate decreases, but the losses in turbines, packings, and the like increase, so that 1500 psi was selected as a practical pressure with which there was already adequate experience.

In Fig. 4 the theoretical fuel rate is shown for different condenser pressures. The curve without allowance for condenser fans would be fairly representative of the theoretical fuel rate for a stationary plant. The curves with allowance for condenser-fan power are based on the horsepower required to cool an actual condenser and do not include fan and drive losses. As a practical compromise condenser pressures were selected varying from about 5 to 25 psi abs, that is, from about 20 in. of vacuum to about 10 psi gage, depending on conditions of load, temperature, and elevation. Actually, it has been found possible to operate over a slightly wider range.

It will be appreciated that weight and space requirements dictate steam and condenser pressures that are higher than would be selected for maximum fuel economy. The condenser sections are located in the sides of the locomotive and air is sucked through them by turbine-driven fans located in the roof.

The electric transmission converts the full power of the turbines over a wide range of locomotive speed. This allows full horsepower utilization continuously over practically the whole range of operating conditions. The long grades can be negotiated without helpers because the electrical equipment




OF APPARATUS

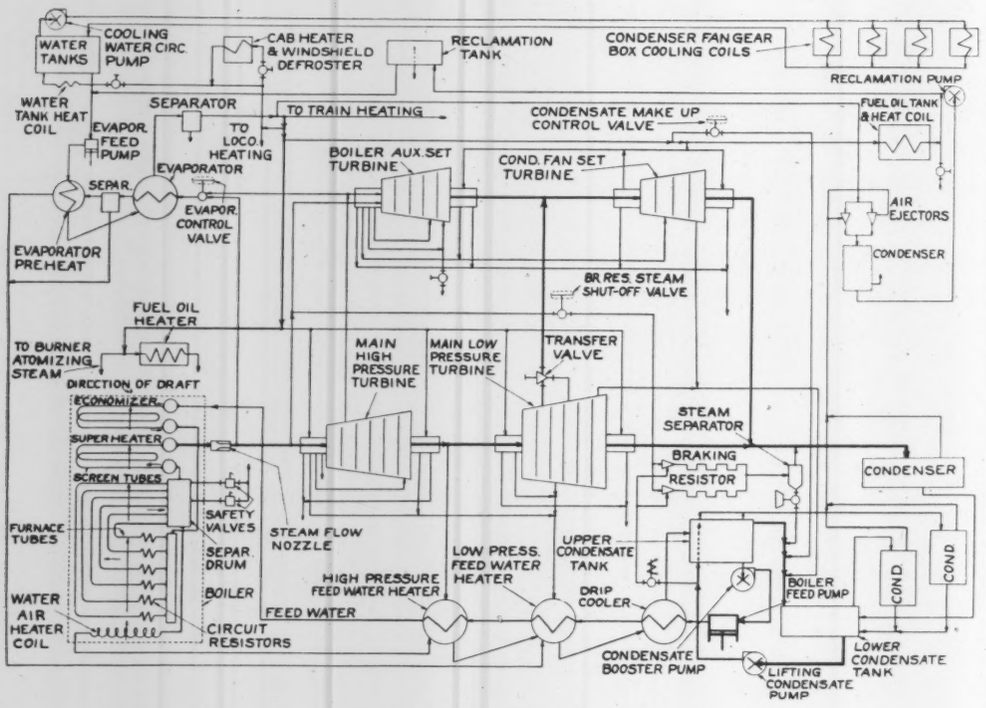



FIG. 6 STEAM-CYCLE DIAGRAM

is able to transmit the full power of the engine continuously.

The control of the locomotive is automatic. If the engineman sets his controller handle at the maximum position, the control will accelerate the train and use all the available power. By notching the controller to intermediate points, the engineman has complete control over acceleration or speed up to the point of maximum power output.

The braking of high-speed trains is one of the most important factors in their design. This locomotive has air brakes suitable for conventional trains, streamlined trains with automatic retardation control, and independent locomotive braking.

The locomotive also has electric braking in which the traction motors act as generators connected to a braking resistor.

The electric braking is used either alone or in combination with train brakes during normal stops or slowdowns and is particularly advantageous when descending long grades. The brake can, for example, hold the locomotive and a trailing train of 1000 tons on a 2 per cent grade at any speed from 20 to 70 mph continuously without requiring any application of the air brakes.

This brake permits easier control and higher safe speeds down grades and eliminates wheel and brake-shoe wear both on the locomotive and on the train except when air brakes are used.

The braking resistor, which absorbs the power generated in the motors, is built in the form of a tube through which water is circulated. During heavy braking, part of this water is turned into steam which is condensed in the main condensers.

### ARRANGEMENT OF APPARATUS

One of the two identical 2500-hp units is illustrated in Fig. 5 which shows the general arrangement of apparatus in the locomotive. The boiler is located in the center so that it can use the space below the cab platform between the trucks. The main turbine generator set is ahead of the boiler and the auxiliary set and condensers are just to the rear. This arrangement was necessary in order to get proper weight distribution and a practical running gear.

On account of the comparatively small size of the main turbine generator set, the air compressor and train heating evaporator are placed above it and arranged for removal without undue work when required for maintenance. The boiler auxiliary set and condenser-fan turbine are built in one unit, located between the boiler and a panel which contains the automatic power-plant control.

The majority of the electric controls are in two groups, the main motor contactors which are in compartments below the frame and the relay and auxiliary control which is in the apparatus cab, behind the operating compartment. The tanks containing raw water for train heating and make-up are in the locomotive nose, each unit carrying 4000 gal.

The fuel-oil tanks, with capacity for 3000-gal per unit, are at the rear between the condensers.

There is a passageway throughout the length of the locomotive with a branch behind the operating cab to allow access to equipment where necessary.

### STEAM CYCLE

Fig. 6 shows the schematic arrangement of the main steam circuits. From the boiler steam goes to the main turbines and

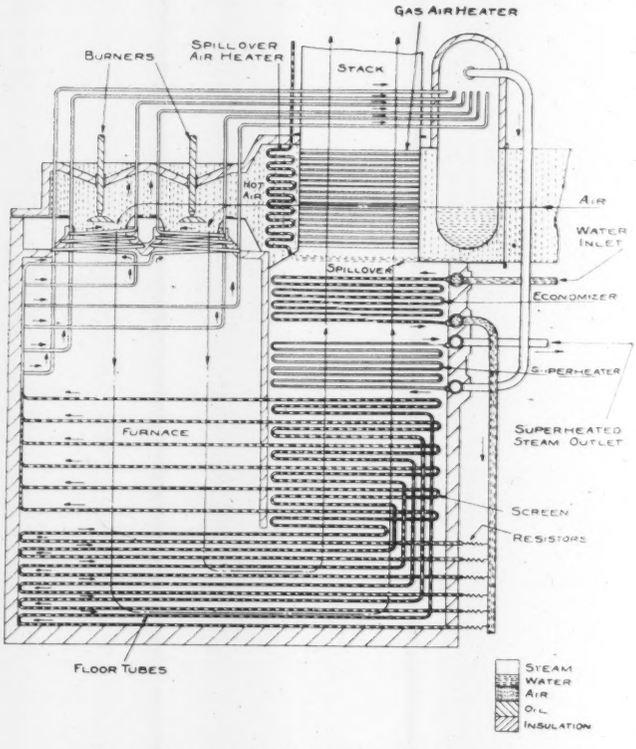



FIG. 7 GENERAL ARRANGEMENT OF STEAMOTIVE BOILER

then to the condensers. The condensate drains to a low-level tank, from which it is pumped to a high-level tank. This tank feeds by gravity into a booster pump which supplies the main high-pressure feed pump. This pump returns the condensate through a feedwater heater to the boiler.

Steam is extracted from the first stage of the high-pressure turbine to drive the auxiliary turbine and condenser-fan turbine, which are connected in series and exhaust into the main condenser. First-stage extraction steam is also used to heat an evaporator, and supplies make-up and train-heating steam. When insufficient extraction steam is available for these purposes, high-pressure steam is automatically supplied through the auxiliary set and evaporator control valves.

Three additional extraction lines from the main turbine are used for feed heaters and for controlling the auxiliary set and condenser fan turbines. Vacuum is obtained by two ejectors operated from evaporator steam. The condensate pump also feeds the braking resistor. The pressure required to force the water through the tubes of the braking resistor is obtained by two injectors using high-pressure steam and the resistor discharges into a separator from which water returns to the low-level condensate tank and steam to the main condensers.

The closed system contains less than 3000 lb of water and, under full load, the water takes about $3\frac{1}{2}$ min to complete the cycle.

### BOILER

The boiler, built by the Babcock & Wilcox Company, delivers steam at 1500 psi and 920 F. Fig. 7 shows the general arrangement. The furnace has two vertical burners. It has water-cooled walls consisting of six circuits of studded carbon-molybdenum steel tubes coated with refractory. After leaving the furnace, the gases pass through a screen section and up through the economizer, superheater, and air heater to the stack.

The separator drum is integral with the boiler. A minimum spillover of about 10 per cent is maintained from the separator drum to the high-pressure feedwater heater. The boiler is self-supporting and is mounted on three points in the locomotive with provision for expansion at one end.

Two high-pressure safety valves are used in accordance with I.C.C. regulations.

### STEAM CONTROL

The Bailey Meter Company developed the automatic control of the power plant. A schematic diagram of this control is shown in Fig. 8. The water delivered to the boiler is determined primarily by the steam flow, as measured by a steam flowmeter. This measurement is used to control the auxiliary-turbine steam valve and thus controls the speed of the feedwater pump and hence its output. As a further check, the water level in the separating drum is measured, and this measurement, serving as a final correction on the water flow, is also relayed to the auxiliary turbine. The fuel-oil pump and combustion-air blower are both driven by the same auxiliary turbine which drives the feedwater pump. They are proportioned so that for a speed suitable to deliver the required quantity of water, they will deliver an excess of oil and air above the quantities required to generate steam from that water. The excess capacity is throttled, the oil by a valve and the air by a damper which has its position modified in accordance with steam pressure. The fuel-oil valve is controlled by metered ratio between oil flow and air flow to maintain proper combustion conditions.

The continuity of combustion is under the control of an electric circuit arranged to:

(1) Light or put out the fire.

(2) Shut off the fuel in the event of high steam pressure, high steam temperature, flame failure due to any cause, or failure of water supply or lubricating-oil supply to the feed pump.

(3) Relight the fire when normal conditions are established.

Propane gas ignited by spark plugs serves to light the fuel oil. With all conditions normal, the propane is lighted and after a few seconds the fuel-oil valve is opened. Photoelectric cells, located to receive light from the oil fire, operate to shut off the igniting torches when normal fire is established. They also shut off the fuel supply and initiate a normal lighting cycle in case the fire goes out. In cases such as lack of fuel oil, the lighting cycle will repeat four times, then lock out until manually reset.

In addition to the main boiler control, the automatic system

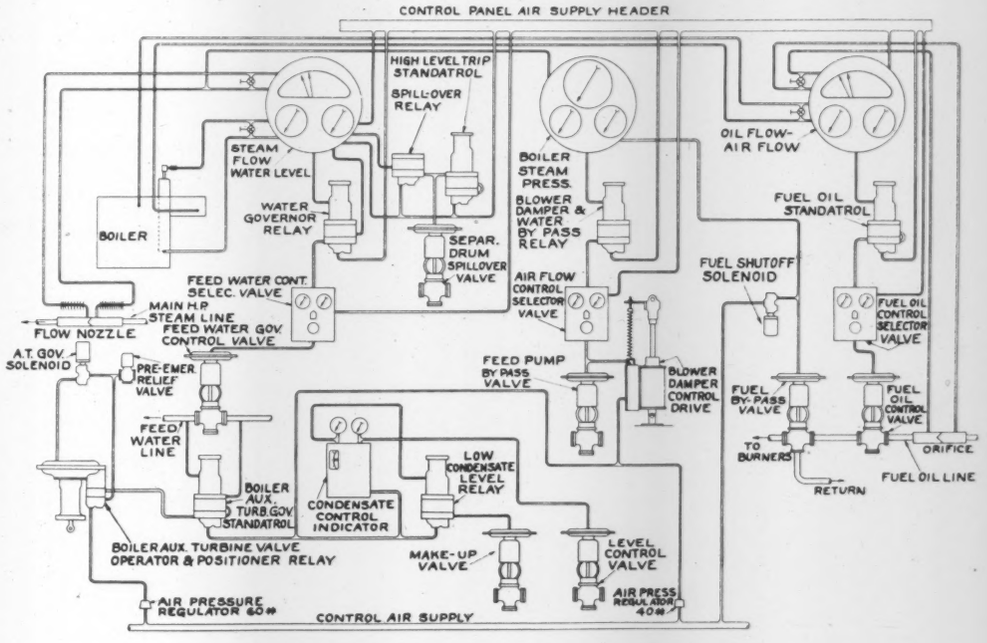



FIG. 8 DIAGRAM OF AUTOMATIC STEAM CONTROL

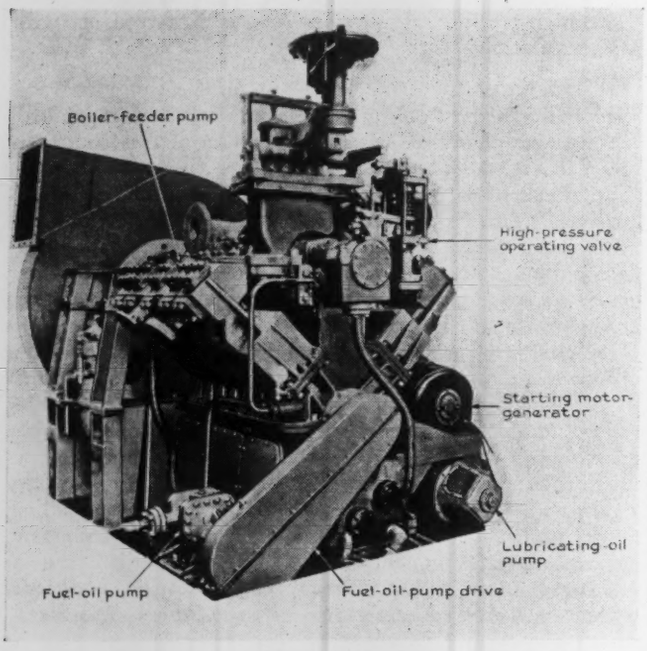



FIG. 9 BOILER AUXILIARY SET

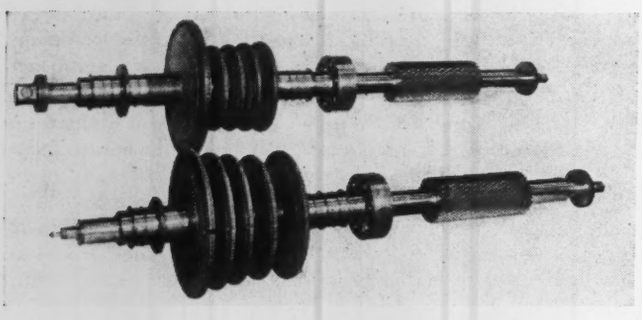


FIG. 10 MAIN TURBINE HIGH- AND LOW-PRESSURE ROTORS

maintains water level in the condensate tank, admitting steam from the evaporator to the closed system if the water is low, or returning water to the raw water tanks if the level is too high. The condenser-fan speed is automatically controlled by the temperature of the condensate return from the condensers. The evaporator also has its own control, which serves to maintain water level and steam pressure in the evaporator shell.

The turbine-driven boiler auxiliary set supplies feedwater, combustion air, and fuel oil to the boiler. The turbine operates on extraction steam and is geared to the feed pump and blower.

### BOILER AUXILIARY SET

The boiler feed pump is of the reciprocating type and has ten cylinders arranged in two banks forming a vee. All cylinders are accessible for packing or for inspection of valves or pistons.

The combustion-air blower is a single-stage, single-inlet unit with an overhung impeller. The fuel-oil pump is chain-driven from the feedwater-pump crankshaft.

The auxiliary set has a geared starting motor which also acts as a generator driving the other motor pumps after the auxiliary turbine is on steam in case the battery-charging set is not running.

The auxiliary set is essentially a variable-speed unit, its speed depending on the load on the boiler. The set is shown in Fig. 9.

### MAIN TURBINE-GENERATOR SET

The main turbine-generator set is made up of three assemblies: a geared turbine, a main direct-current generator, and an auxiliary alternator exciter.

The turbine is a cross-compound machine with two pinions running on a common gear. The turbine rotors run at 12,500 rpm and the gear at 1200 rpm. The two turbine rotors weigh approximately 600 lb each and are shown with their pinions in Fig. 10.

The geared turbine is connected through a flexible coupling to the main direct-current generator which is a double machine, made up of two 12-pole, variable-voltage generators built back to back.

The main generator is direct-coupled to a third unit which consists of an alternator and an exciter. The alternator supplies 230-v, 3-phase, 60-cycle, alternating-current power for use where head-end power is required for air conditioning and also provides for traction-motor blowers and minor auxiliaries on the locomotive. The exciter is used to excite the main-generator fields during traction and the traction-motor fields during electric braking. It compensates for changes of field resistance with temperature and keeps the locomotive characteristics constant. It also permits a cold locomotive to be coupled to a hot one and the two operated in multiple without unbalance of motor currents between the two units. The complete turbine-generator-exciter set is shown in Fig. 11.

*(To be concluded in the next issue)*

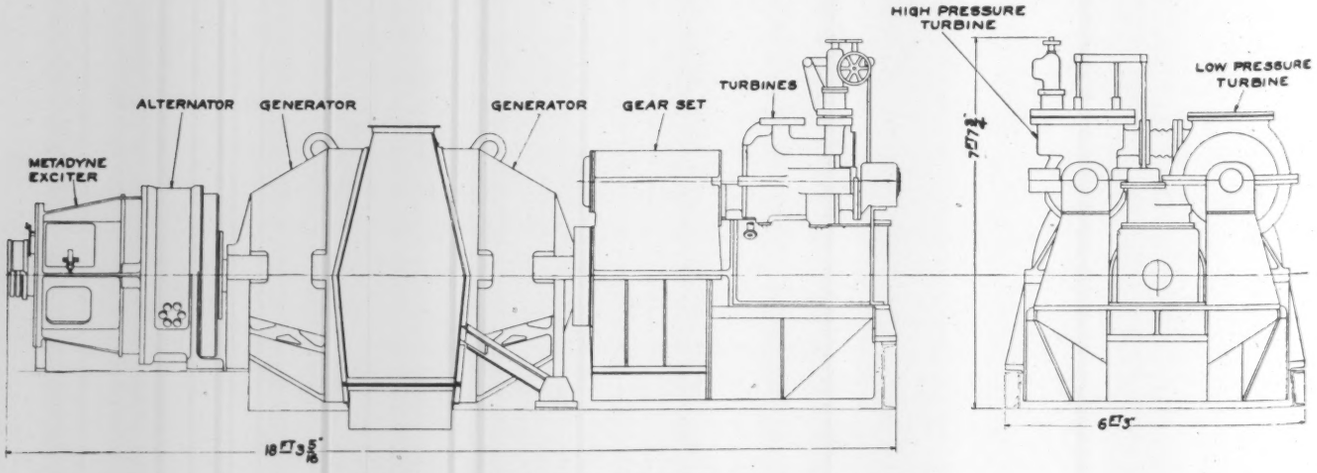



FIG. 11 OUTLINE OF MAIN TURBINE-GENERATOR-EXCITER SET

# ROUTING NIGHTMARES *of* WATER CONDITIONING

By R. E. HALL, E. P. PARTRIDGE, and T. H. DAUGHERTY

HALL LABORATORIES, INC., PITTSBURGH, PA.

QUITE likely no reader has hitherto heard of Limbo Station. It is our purpose to acquaint you with this unique place, more particularly to discuss a few of the major problems relating to water that have occurred there recently, and to present the application of the principles of water conditioning whereby these problems have been solved.

Limbo is the region located on the fringe of Hades. It is here that the River Styx is supposed to flow seven times around Hades, and where Charon, the boatman, collects the toll for rowing departed spirits across to the realms of Pluto, who assigns them according to their merits to joyous Elysian fields or to the grim regions of Tartarus. On the shores of the Styx, at its confluence with the Phlegethon, the river of fire, we have located Limbo Station, a mythical power plant, which has been troubled with the many nightmares which have been consigned to Hades by those power-plant operators of the upper real world, who waking or sleeping have been relentlessly pursued by them. Thus, while Limbo Station is a myth of convenience and a concentration camp of power-plant troubles condemned to it from the world above, its problems and examples are units or composites of real experience in many plants.

The administration of Limbo Station is so arranged that the application of solutions to its problems is relatively easy. All officers are engineers, and characters like red tape, overlords, unsympathetics lacking understanding of the technical necessities, indiscriminating purchasing agents, and even mild obstructionists of progress, have been banished to Hades on the other side of the river Styx. The situation at Limbo is thus much more ideal than is usually met in the mundane stations, in that the engineers, having agreed upon the logical methods of solving any problem, initiate them without the delay and the many annoyances so commonly encountered. However, the cost involved in the solution of any problem at Limbo Station must be justifiable, because all of the world's capital is not yet in Hades, even though it may be heading in that direction at present.

At one time or another, and for one reason or another, probably every boiler that was ever erected has been consigned to Limbo by its operators, when its caprices have haled them from their homes or their recreation and demanded their attention. Wherefore, though originally intended solely as a waste-heat-recovery operation in connection with the great furnaces of Hades, Limbo Station is equipped with boilers of every variety of design.

Presented at a joint meeting of the Fuels Division, A.S.M.E., and the Coal Division, A.I.M.E., held in Chicago, Ill., Oct. 13–15, 1938.

### CRACKING IN TUBE ENDS

In one of these boilers, the general layout of which is indicated in Fig. 1, an interesting case of cracked tube ends developed. The failures were localized at the upper ends of the tubes in the economizer section, and occurred only at one end of the drum. The cracking originated in the outer surface of the tubes where they were expanded into the recess grooves in the tube sheet, as shown in Fig. 2. The predominantly intergranular character of the fine cracks adjacent to the main fracture is shown in Fig. 3.

This occurrence provided an exceptionally fine case for the devil's advocate. Drawing first the obvious conclusion from the intergranular cracks that this was a case of embrittlement, he pried into the chemical history of the boiler water. It was found that condensate with the typical composition given in Table 1, was used for make-up, and that caustic soda and sodium sulphate were added to the boiler water as required to maintain a pH value of 11 and an A.S.M.E. sulphate-alkalinity ratio above 3, producing a boiler water with the typical composition shown in Table 2. Discovering that, on a few occasions, the sulphate-alkalinity ratio had fallen below the recom-

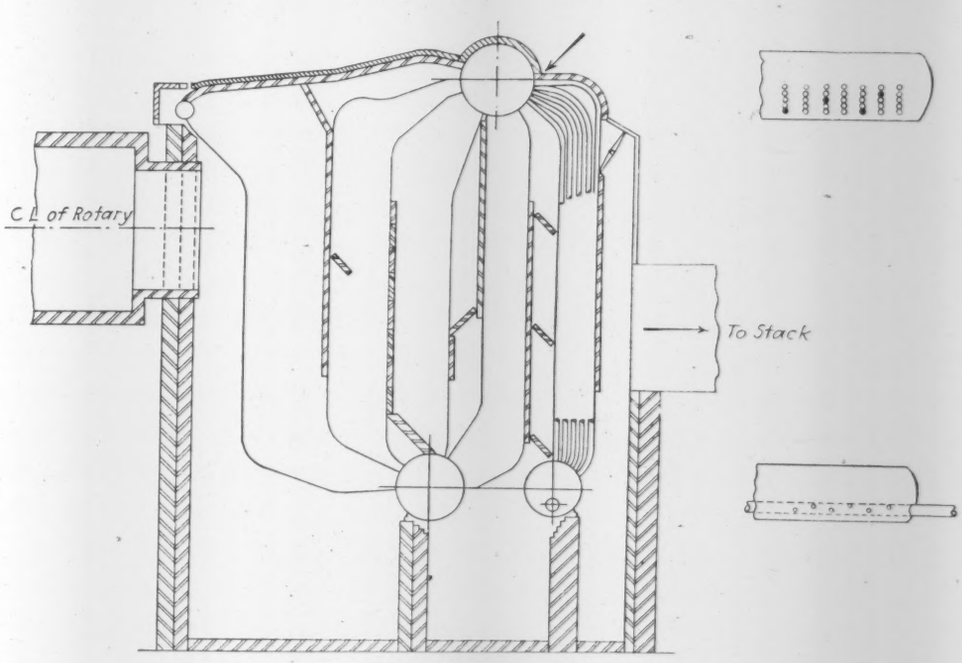



FIG. 1 SHOWING THE LAYOUT OF BOILER WITH THE REGION OF CRACKING INDICATED BY ARROW

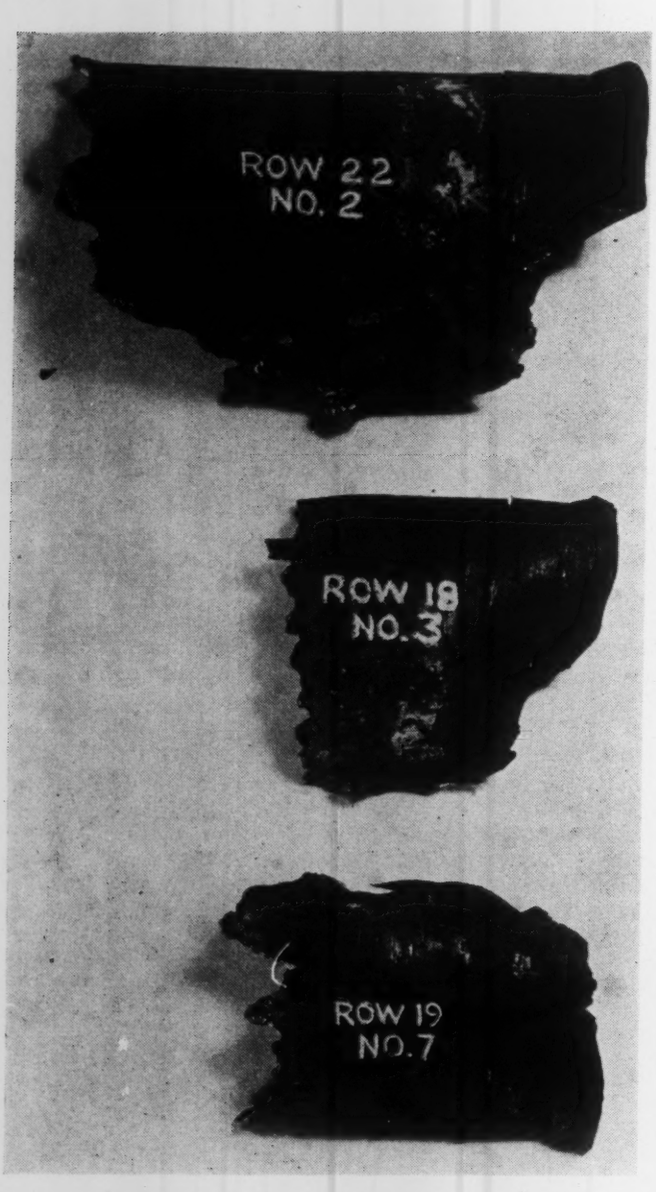



FIG. 2 EXTERNAL SURFACES OF CRACKED TUBE ENDS

mended value, the devil's advocate promptly indicted the superintendent, the boiler foreman, and the plant chemist for sabotage. Pluto himself then took up their defense, calling in the experts to render reports.

The first expert explained that after all, even if the recommended ratio of sulphate to alkalinity had been maintained, the cracking would still have been likely to occur, unless the requirements of a newly devised additional ratio of sodium-chloride to alkalinity had also been met. Then Pluto called his next expert, who seconded the statement of the first one, that maintenance of the sulphate-alkalinity ratio was inadequate to prevent embrittlement, and then added that the chloride-alkalinity ratio seemed to have equally little significance.

So far as chemical treatment was concerned, the most effective inhibitors of intergranular attack yet found, according to his investigations, were lignin derivatives and certain of the tannins. At this point, the third expert volunteered his opinion, that the cracking was not embrittlement but corrosion fatigue. As he saw it, water entering the perforated feed pipe in the lower economizer drum at a temperature of about 170 F

TABLE 1 COMPOSITION OF FEEDWATER

| | Ppm |
|---|---|
| Hydroxide (OH) | 0 |
| Carbonate ($CO_3$) | 0 |
| Bicarbonate ($HCO_3$) | 2 |
| Sulphate ($SO_4$) | 1 |
| Chloride (Cl) | 1 |
| Soap hardness ($CaCO_3$) | 2 |
| pH 6.6 | |

TABLE 2 COMPOSITION OF BOILER WATER

| | Ppm |
|---|---|
| Hydroxide (OH) | 55 |
| Carbonate ($CO_3$) | 14 |
| Sulphate ($SO_4$) | 431 |
| Chloride (Cl) | 18 |
| Silica ($SiO_2$) | 9 |
| Soap hardness ($CaCO_3$) | 9 |
| pH 11.3 | |

$$\frac{Na_2SO_4}{\text{Alk as } Na_2CO_3} \quad 3.2$$

below the water temperature in the upper drum, tended to short-circuit upward through the tubes at the end near the feed inlet. The upper end of the tube would accordingly be subjected to repeated fluctuations in temperature, with resultant repeated stresses. When the tube sheet started to leak as the result of repeated expansion and contraction, corrosion was stimulated by the local stresses, producing chemically formed notches, which under the effect of repetition of stress led to

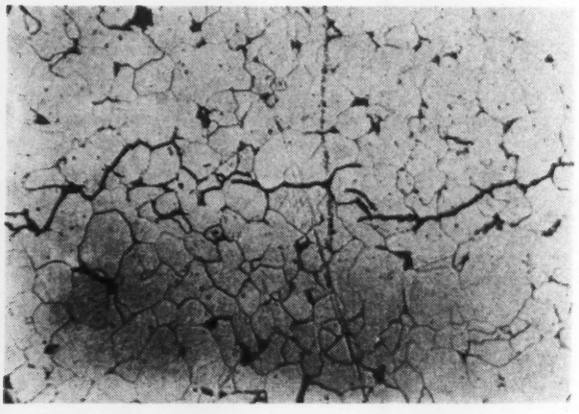


FIG. 3 INTERGRANULAR CRACKING OF TUBE END

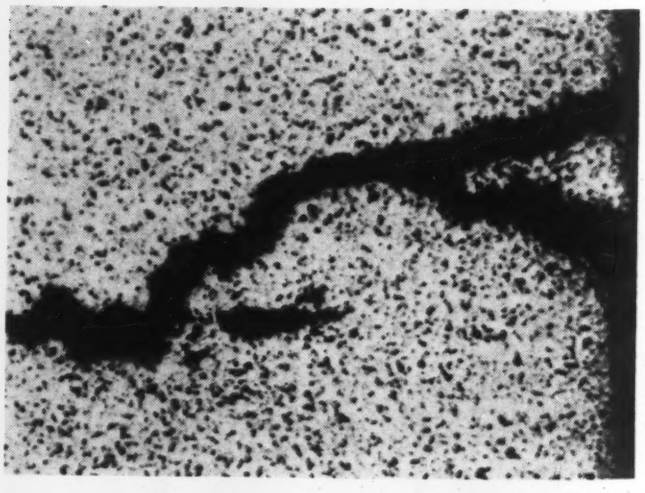


FIG. 4 PHOTOMICROGRAPH OF CRACK IN TUBE END WHICH IS NOT INTERGRANULAR IN NATURE

fatigue failure. As evidence, there was produced the photomicrograph of Fig. 4 showing a crack in one of the tube ends decidedly not intergranular in nature.

Long before the third expert was through with his testimony, Charon, the water tender, was on his feet. When given a chance to speak, he brought out the fact that the end of the lower economizer drum had been found resting on the brickwork at the time of the last failure of a tube end. How long the wall had been supporting this end of the economizer, which was supposed to hang freely from the upper drum, no one could guess, but it looked as if, due to the design of the economizer section, a considerable lever action might have been exerted by the tubes at their seat in the upper drum.

From then on, the Stygian air was filled with rebuttal until Pluto, tiring of the argument, pulled out the poker chips, and every one sat down to a quiet little game. By the time Charon had been cleaned of his last ferry fare, an amicable agreement had been reached to maintain the A.S.M.E. ratio, establish the chloride-alkalinity ratio, feed sulphite waste liquor as a source of lignin, change the design of the feed pipe to produce better mixing in the lower economizer drum, and insure free suspension of this drum. That at least one of these was the right thing to do has been attested by subsequent operation of this unit without further cracking.

### STEAM-LINE AND TURBINE DEPOSITS FROM LACK OF STEAM CIRCULATORS

Late one hot Saturday afternoon in July in Vulcan's department of Limbo Station, the turbine operator noticed that when the load on the 15,000-kw turbine was reduced from 12,000 to 10,000 kw, five valves closed. Usually a drop of 2000 kw in the turbine load would result in only one valve closing. This indicated to the turbine operator that the screen ahead of the turbine had become plugged. The turbine was taken off the line, and on Sunday morning this screen was removed. It was found to be coated with a deposit varying from $^1/_8$ to $^1/_4$-in. in thickness. The deposit was washed from the screen with water, and the screen replaced in the steam line ahead of the turbine. The turbine was placed on the line about 4 a.m. Monday, and about seven hours later it began to lose its load. The load was taken off the turbine for a few minutes and then put back on it. It responded normally, handling all the load that was given to it. It was decided, however, to shut down the turbine and to examine the screen again. This time no deposit was found on the screen. However, about two or three pints of loose deposit were found in the steam line below the screen. Apparently this deposit had collected on the screen, but when the load was taken from the turbine it dropped off. After cleaning the loose deposit from the steam line below the screen, the screen was replaced, and the turbine put into operation. It handled a load of more than 15,000 kw without any trouble.

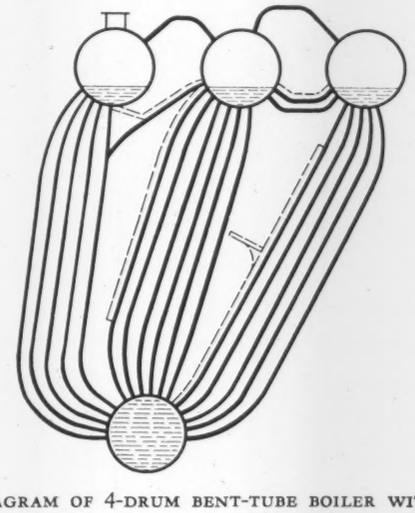


FIG. 5 DIAGRAM OF 4-DRUM BENT-TUBE BOILER WITH INSUFFICIENT CROSS-OVER TUBES

Table 3 presents an analysis of the deposit on the screen ahead of the turbine. It was found to be almost entirely water-soluble. It consisted very largely of sodium sulphate. Thus its origin was indubitably carry-over of boiler water in the steam. Table 4 gives the analysis of a typical boiler water, and the lime-soda-treated feedwater from which it was derived. Vulcan's part of Limbo Station had no condensate returns, a feedwater of relatively high content of total solids, and a boiler water of considerably higher concentration than could be tolerated in the more modern boilers, but which in the four-drum bent-tube boilers, Fig. 5, which had been consigned to this part of Limbo some years previously, did not produce impossible conditions, particularly if the ratings were not too high. Besides, these boilers had been equipped with an additional separate drum, housing well-recognized steam purifying equipment, with discharge of water by traps and venting of the traps, which represented the best practice.

TABLE 3 LACK OF STEAM CIRCULATORS—DEPOSIT ON SCREEN AHEAD OF TURBINE

| | Per cent |
|---|---|
| Sodium sulphate ($Na_2SO_4$) | 81 |
| Sodium chloride (NaCl) | 1.8 |
| Alkalinity as $Na_2CO_3$ (Includes sodium carbonate and sodium silicate) | 11.4 |
| Sodium phosphate ($Na_3PO_4$) | 1.0 |
| Total water-soluble solids | 92.5 |
| Total water-insoluble solids | 7.5 |

We need but mention how Vulcan called in his assistants and experts, and how the Stygian air was again filled with argument and rebuttal. The conclusion was reached that only fog in the steam could pass through the lines of defense which had been provided and that the fog was caused by too great velocity of the steam and water as it was discharged from the steam cross-over tubes into the rear or steam-offtake drum. It was agreed that elimination of the fog necessitated greater steam-carrying capacity between the middle and the rear drum. With agreement reached, Vulcan proceeded immediately to increase the steam cross-over tubes between the middle and the rear drum in the ratio of 4 to 1, and the results have fully justified the cost in this case as in many others. It is worthy of note that this change had been recommended by the boiler manufacturers some years before the boilers had been consigned to Limbo Station, but in the upper world of reality, the engineers have yet to banish to the Hades' shore of the Styx those condi-

TABLE 4 LACK OF STEAM CIRCULATORS—WATER CONDITIONS

| | Feedwater lime-soda-treated, ppm | Boiler water, ppm |
|---|---|---|
| Sodium hydroxide (NaOH) | 4.5 | 385 |
| Sodium carbonate ($Na_2CO_3$) | 53 | 254 |
| Sodium phosphate ($Na_3PO_4$) | | 151 |
| Sodium sulphate ($Na_2SO_4$) | 200 | 3550 |
| Sodium chloride (NaCl) | 7 | 148 |
| Silica (app.) ($SiO_2$) | 8 | |
| Sodium silicate (app.) ($Na_2SiO_3$) | | 100 |
| Hardness as $CaCO_3$ | 11 | |
| Organic | | Very little |
| Total dissolved solids | 283.5 | 4588 |
| Per cent blowdown | 6.2 | |

tions and forces which hamper and retard them in their solution of problems.

### A NEW BOILER IS A DIRTY DISH

A new problem was introduced when unexpectedly some new high-pressure boilers were consigned to Limbo Station, boilers that had not been operated, and whose surfaces were still befouled with the grease and the other debris incident to fabrication and erection. In view of the trouble experienced with cracking of tube ends, and of the information which has become available relative to the effectiveness of silica in causing embrittlement; also, in view of the fact that considerable doubt had been expressed by the experts relative to the effectiveness of the sulphate-alkalinity ratios in preventing embrittlement, the engineers at Limbo hesitated to follow the rules given in the Boiler Code for washing out boilers, since these rules were established long before these recently developed facts were available. Besides, the old process of using soda ash and caustic only is very time-consuming, and makes use of none of the principles of detergency which have been highly developed in other operations where the strictest cleanliness is essential.

After all, as their water expert pointed out, these new boilers were merely big dishes that should be cleaned as spotlessly as dirty dishes are cleaned in our most modern restaurants. He went on to say that the old-fashioned empirical process of dishwashing has given way before the science of dish conditioning, and that the more potent detergents which have been developed will clean dishes to a point where thay are perfectly film-free to the eye and touch, and show no lime film under the microscope. This is especially essential in the cleansing of a new boiler, otherwise in its earlier operation the permissible quality of the boiler water, and the quality of steam, will be in doubt owing to the organic contamination in the boiler water from such film. All being in agreement, a detergent containing 40 per cent sodium hexametaphosphate and 60 per cent of alkaline constituent was selected; the sodium hexametaphosphate represented the constituent essential to certain film removal.

Just as in the cleansing of dishes in a dishwashing machine, the water in contact with the boiler surfaces must be maintained alkaline, and this is effected by the addition of small amounts of caustic soda when tests of the water show the need therefor. To protect against any possible chance of embrittlement during the boiling-out operation, the A.S.M.E. sulphate-alkalinity ratio can be maintained by addition of sodium sulphate, but this occasions rather high salt concentration in the boiler water, and the preferred alternative is to provide this protection by the use of the requisite amount of a sodium lignin sulphonate or a dispersive tannin. The protectiveness of these materials has been particularly emphasized by the research work carried on at the U. S. Bureau of Mines under the auspices of the Joint Research Committee on Boiler Feedwater Studies.

On these new boilers at Limbo Station the chemicals used for conditioning the water for the washing-out process consisted of 3 lb of Calgonite,[1] 0.6 lb of caustic soda, and 0.1 lb of dispersive tannin for every thousand pounds of water added to the boiler in filling to the half-gage glass level. While the development of a pressure of 25 lb was fully satisfactory for the cleansing process, it is necessary that circulation be obtained, and to make certain of this, the pressure was allowed to go higher, but not above 300 lb.

With this procedure followed, the boilers after draining and rinsing were found in excellent condition after a single period of detergent action of from six to twelve hours. And although time may be cheap in Hades, the operators were impressed by the fact that fully satisfactory results had been obtained in this brief procedure instead of one measured by days, by the application to the problem of cleansing of the detergency principles now available.

### CONDENSER-TUBE SCALE PREVENTION BY THRESHOLD TREATMENT

Almost before the new units had been broken in, trouble developed in the condensers. The cooling water, taken from the Styx just after it emerged in Hades from its course through a limestone deposit, was high in calcium and bicarbonate ions as shown by the analysis in Table 5. As a result, calcium-carbonate scale formed in the condensers at such a rate that it was necessary to clean them monthly with wire brushes and 10 per cent hydrochloric acid to maintain satisfactory vacuum.

TABLE 5 COMPOSITION OF COOLING WATER

| | Ppm | Epm |
|---|---|---|
| Bicarbonate ($HCO_3$) | 475 | 7.78 |
| Sulphate ($SO_4$) | 173 | 3.60 |
| Chloride (Cl) | 36 | 1.00 |
| Silica ($SiO_2$) | 15 | 0.50 |
| Calcium (Ca) | 135 | 6.75 |
| Magnesium (Mg) | 45 | 3.70 |
| Sodium (Na) | 44 | 1.93 |
| Total dissolved solids | 661 | |
| Hardness as $CaCO_3$ | 723 | 10.45 |

| Lime-soda softening: | Zeolite softening: |
|---|---|
| Lime required 459 lb; soda ash 165 lb per million lb water | Salt required 2090 lb per million lb water |

Various expedients were urged upon the operators by the local salesmen. The first suggestion was continuous treatment with sulphuric acid, which was available at low cost from the local industry based on brimstone. However, when calculation showed that approximately 150 lb of 66 deg Baumé $H_2SO_4$ would be required per million pounds of water entering the system, and when the difficulty of controlling the acid feed and the probability of corrosion were considered, the idea was abandoned.

The next thought was organic substances such as tannin. Several proprietary compounds containing this material were tried, but the amounts necessary to prevent scale deposition satisfactorily were prohibitively expensive. The plant was just on the verge of a considerable capital expenditure for a forced-circulation cooling tower with zeolite softening of the make-up water when one of the engineers came in with the unbelievable story that 2 lb of sodium hexametaphosphate to a million pounds of their raw water would prevent scale in the condenser. He had heard this, moreover, from no less a person than the chief engineer of the big distillery over in the Elysian fields, who claimed that not only was this minute amount preventing scale in his mash coolers and condensers, but that it had removed old scale from the system.

After a thoroughly skeptical inquiry, the superintendent agreed to try out this miraculous "threshold treatment" on the cooling system at Limbo Station. Within three months he was recommending it to other plants in the system farther down the Styx, not only for cooling water, but also for keeping the deaerating heater and boiler feed lines free of calcium carbonate scale (Fig. 6). Moreover, the Metropolitan Water Commission of Hades had adopted threshold treatment with sodium hexametaphosphate for preventing afterprecipitation of calcium carbonate in the distribution system supplying softened water from the River Lethe to the Elysian fields, and also in obviating scale formation in the heaters supplying hot water from the River Acheron to the punishment cells in Tartarus.

[1] The chemical composition of Calgonite, as given by Schwartz and Gilmore, *Industrial and Engineering Chemistry*, vol. 26, 1934, pp. 998–1001 (see p. 1001), is 40 per cent sodium metaphosphate, 15 per cent trisodium phosphate monohydrate, 40 per cent sodium metasilicate pentahydrate, and 5 per cent caustic soda.

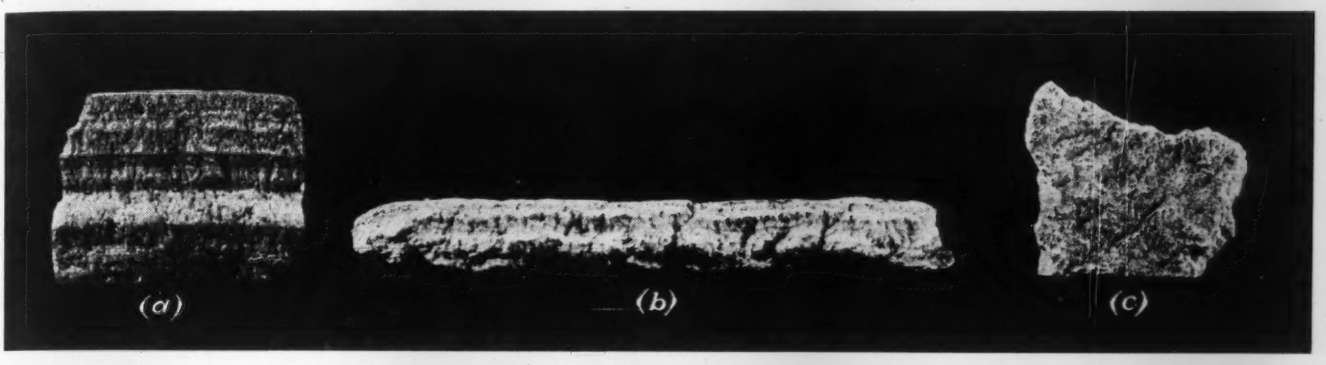



FIG. 6 DISINTEGRATING EFFECT OF NINE MONTHS' THRESHOLD TREATMENT ON CALCIUM-CARBONATE SCALE IN PIPE LINE
(Cross sections of (*a*) original scale, (*b*) scale after nine months showing disintegration at both surfaces, and (*c*) surface of scale after nine months.)

### PROBLEMS OF SODIUM-ALUMINUM-SILICATE DEPOSITION

Boiler deposits of sodium-aluminum-silicate began to be recognized a few years ago following recognition of the necessity of complete treatment of boiler waters, and nearly simultaneously with the inception of higher ratings or higher rate of heat input, and higher pressures. Deposits of this type have been severe troublemakers, and it is not surprising therefore that the various phases of this problem appear at Limbo Station. Before entering into discussion of specific cases, let us describe the mechanism of formation of the deposits which is common to all.

As a bubble of steam forms on a hot-tube surface there is deposited on that surface the solids which were in the water from which the steam formed, as shown in Fig. 7. This deposit momentarily assumes the temperature of the tube, which is probably higher than that of the water. The next moment when the steam bubble escapes, water covers the surface where the deposit was formed, and according to the ease with which they go into solution, the substances composing the deposit will redissolve. If there is time enough, all of them will redissolve and the sludge particles will be again suspended in the water. If the time is too short, then those that dissolve most readily will be dissolved, but others will be left behind. Whether or not all of the deposit will dissolve is determined by the time elapsing between the formation of successive steam bubbles on this surface, and the rate of solution of the substances deposited.

While most sodium salts redissolve readily, sodium silicate does not, although, as a matter of fact, it is quite soluble in water, as evidenced by water glass, which is a concentrated solution of this substance. However, if a film of water glass is painted on a surface and allowed to dry, it is common experience to all of us that it is extremely difficult to get it back into solution. In a boiler tube the situation is quite similar. The boiler water contains sodium silicate in solution, and upon evaporation to dryness at the tube surface, this film of sodium silicate is deposited on the metal along with other salts. It seems probable that, from the sodium silicate laid down on the boiler tube, its hydrolysis product, caustic soda, is washed off preferentially to the other hydrolysis product, which is hydrated silica. This leads to two possibilities, both of which have been demonstrated by deposits we have examined. First, the hydrated silica may dehydrate to silica or quartz at the high temperature of the tube metal. Table 6 shows an analcite scale

TABLE 6 QUARTZ-CONTAINING SODIUM-ALUMINUM-SILICATE SCALE
(Operating pressure: 450 lb)

| | Per cent |
|---|---|
| Sodium aluminum silicate ($Na_2SiO_3 \cdot Al_2[SiO_3]_3$) | 32.2 |
| Silica (quartz) ($SiO_2$) | 26.5 |
| Magnesium silicate ($MgSiO_3$) | 5.2 |
| Iron oxide ($Fe_2O_3$) | 10.0 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | 10.3 |
| Sodium phosphate ($Na_3PO_4$) | 1.3 |
| Sodium silicate ($Na_2SiO_3$) | 6.8 |
| Ignition loss | 9.2 |
| | 101.5 |

FIG. 7 SOLIDS DEPOSITED BY BUBBLE OF STEAM ON HOT TUBE SURFACE

in which crystalline quartz was also actually present to the extent of 26.5 per cent. Second, the hydrated silica may react with other constituents present such as sodium aluminate, to form a more insoluble compound with the elimination of water as follows:

$$2NaAlO_2 + 4H_2SiO_3 = Na_2SiO_3 \cdot Al_2(SiO_3)_3 + 4H_2O$$

At the customary pH values of boiler waters, any alumina present will be in the form of sodium aluminate to considerable extent, and hence the analcite found in the deposit may readily form in accordance with the reaction just given.

Increase in temperature corresponding to operation at higher pressures tends to produce analcite deposits containing higher percentages of sodium salts such as sodium sulphate and sodium phosphate, both because these salts are less soluble at high temperatures, and because their redissolving is retarded to a greater extent by the more rapid dehydration of the hydrated silica to form a coating over them. In Table 7 are presented the results of analysis of such a deposit from a 725-lb bent-tube boiler.

Also, it is quite usual to find in an analcite scale constituents

which would otherwise be sludge if they were not cemented or occluded in the deposit by the sodium aluminum silicate. The sludge constituents of these scales are calcium phosphate and magnesium silicate, as shown in Tables 6 and 7. Table 8

TABLE 7 SODIUM-ALUMINUM-SILICATE SCALE CONTAINING APPRECIABLE WATER-SOLUBLE CONSTITUENTS

(Operating pressure: 725 psi.)

| | Per cent |
|---|---|
| Sodium phosphate ($Na_3PO_4$) | 6.7 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | 10.4 |
| Magnesium hydroxide ($Mg(OH)_2$) | 0.6 |
| Magnesium silicate ($MgSiO_3$) | 5.8 |
| Sodium aluminum silicate ($Na_2SiO_3 \cdot Al_2(SiO_3)_3$) | 61.6 |
| Aluminum silicate ($Al_2(SiO_3)_3$) | 2.3 |
| Iron oxide ($Fe_2O_3$) | 5.6 |
| Ignition loss | 7.4 |
| | 100.4 |

TABLE 8 SODIUM-ALUMINUM-SILICATE SCALE SHOWING INCLUSION OF SLUDGE

(Operating pressure: 600 psi.)

| | Per cent |
|---|---|
| Sodium aluminum silicate ($Na_2SiO_3 \cdot Al_2(SiO_3)_3$) | 10.5 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | 1.6 |
| Zinc phosphate ($Zn_3(PO_4)_2$) | 25.9 |
| Lead phosphate ($Pb_3(PO_4)_2$) | 13.8 |
| Magnesium silicate ($MgSiO_3$) | 4.0 |
| Aluminum oxide ($Al_2O_3$) | 1.9 |
| Iron oxide, magnetic ($Fe_3O_4$) | 22.0 |
| Copper (Cu) | 4.7 |
| Sodium sulphate ($Na_2SO_4$) | 0.7 |
| Sodium phosphate ($Na_3PO_4$) | 1.5 |
| Sodium silicate ($Na_2SiO_3$) | 8.5 |
| Ignition loss | 6.1 |
| | 101.2 |

shows a number of materials that have been occluded by the 10.5 per cent of the sodium aluminum silicate, and the 8.5 per cent of the sodium silicate.

It will be noted that this mechanism for the formation of analcite postulates an instantaneous localized evaporation of boiler water to dryness, repeated so frequently that the substances deposited cannot redissolve. Hence in the sections of a boiler where the tubes are doing the most work, these analcite scales would be most likely expected, and the greater the rating on these tubes the more of this scale should be formed. The more scale formed, the more likely it is that these tubes will become overheated and burn out. The first example from Limbo Station, the analysis just given in Table 6, is of scale from the tubes of a 450-lb bent-tube boiler, operated at about 600 per cent rating. A similar boiler alongside on the same water, but operated at a lower rating, had no scale and no burned tubes, but when the rating was increased, it, too, burned out some tubes due to this type of scale. This problem was met by the eventual installation of some additional boilers which had been consigned to Limbo, and which allowed lowering of the rating, thus relieving these tubes of their heavy load, and permitting boiler water to flush their surfaces sufficiently constantly so that complete redissolution of any deposition occurred.

One obvious way of preventing a sodium-aluminum-silicate scale is to eliminate the alumina, although this does not obviate the possibility of an accumulation of silica. In a second example at Limbo Station, four-drum, bent-tube, stoker-fired boilers with waterwalls developed trouble from sodium-aluminum-silicate scale in the front waterwall tubes, and there was heavy formation of this scale in the front boiler tubes. Make-up was 100 per cent of city water, which was coagulated with alum and filtered by the city, and sent into the mains with a pH value of approximately 9. In eliminating the trouble, the first expedient was to stud and lag the front waterwall tubes over a considerably larger portion of them, thus decreasing the heat transfer in what seemed to be a critical area. The second expedient was to eliminate the alumina, which was present in the city water supply. As this water was softened at the plant by a zeolite softener, a further chance was presented for the alkaline water to dissolve some material from the zeolite. The substitution of one of the newer organic base exchangers for the original green sand might have been given consideration, but this, however, would not eliminate the alumina from the raw water. Instead, treatment with $CO_2$ just prior to the zeolite softener was instituted to lower the pH value of the water to 7, where the alumina precipitated and was removed at the zeolite filter, and where the water would not attack the green sand to any appreciable extent. The combination of studding and lagging the front waterwall tubes, and of $CO_2$ treatment for lowering the pH value of the raw water, has solved this problem.

TABLE 9 TYPICAL SODIUM-ALUMINUM-SILICATE SCALE

(Operating pressure: 250 psi.)

| | Per cent |
|---|---|
| Sodium aluminum silicate ($Na_2SiO_3 \cdot Al_2(SiO_3)_3$) | 73.3 |
| Sodium silicate ($Na_2SiO_3$) | 16.8 |
| Iron oxide ($Fe_2O_3$) | 0.8 |
| Aluminum oxide ($Al_2O_3$) | 2.0 |
| Ignition loss | 8.2 |
| | 101.1 |

Table 9 is an interesting example of a quite pure analcite and sodium-silicate scale formed at only 250 psi pressure, and occasioned by sodium silicate added to the regular plant water for prevention of corrosion, and by alumina getting into the boiler water from silt in a small percentage of raw unfiltered make-up water.

### A PROBLEM OF DESUPERHEATING

Some boilers were consigned hurriedly to Limbo Station accused of severe carry-over of boiler water in the steam. Let us examine the record. There were two different cases. Table 10 shows the feedwater in each case, one containing 47 lb of total solids per million pounds, and the other 90 lb. Table 11 shows the nature of deposits, in case 1 on a strainer following the desuperheater, and in case 2 on a valve following the desuperheater, which evoked the sentencing of these boilers to Limbo. In case 1, there was a turbine deposit also consisting largely of silica which got by the strainer, but containing a scattering of other constituents as well, Table 12.

TABLE 10 PROBLEMS OF DESUPERHEATING—BOILER-WATER CARRY-OVER

| | Feedwaters, ppm | |
|---|---|---|
| | Case 1 | Case 2 |
| Calcium carbonate ($CaCO_3$) | 16 | 3 |
| Magnesium carbonate ($MgCO_3$) | .. | 3 |
| Sodium carbonate ($Na_2CO_3$) | .. | 9 |
| Magnesium sulphate ($MgSO_4$) | 8 | .. |
| Sodium sulphate ($Na_2SO_4$) | 6 | 61 |
| Sodium chloride (NaCl) | 3 | 11 |
| Silica ($SiO_2$) | 3 | 3 |
| Sodium metaphosphate treatment | 11 | .. |
| Total solids | 47 | 90 |

Now, let us examine the characteristics of the pressure-reducing and desuperheating system shown in Fig. 8. In this system a controlled amount of water is introduced into the steam following the venturi valve, and by its total evapora-

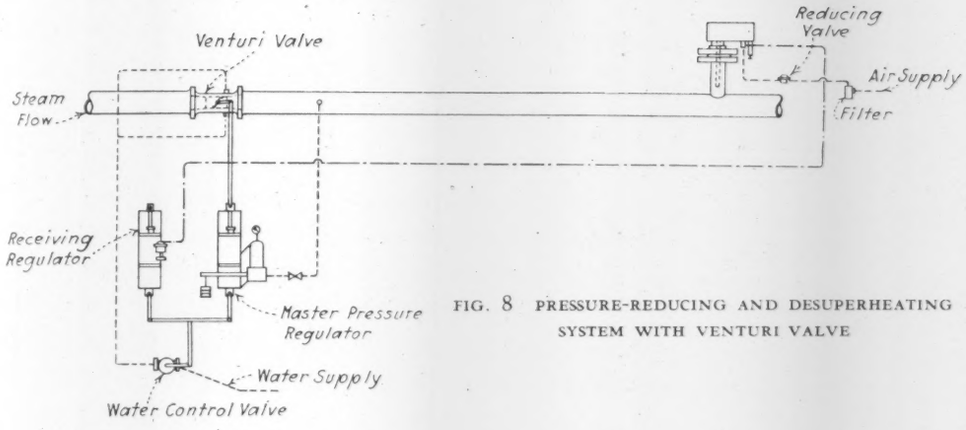



FIG. 8 PRESSURE-REDUCING AND DESUPERHEATING SYSTEM WITH VENTURI VALVE

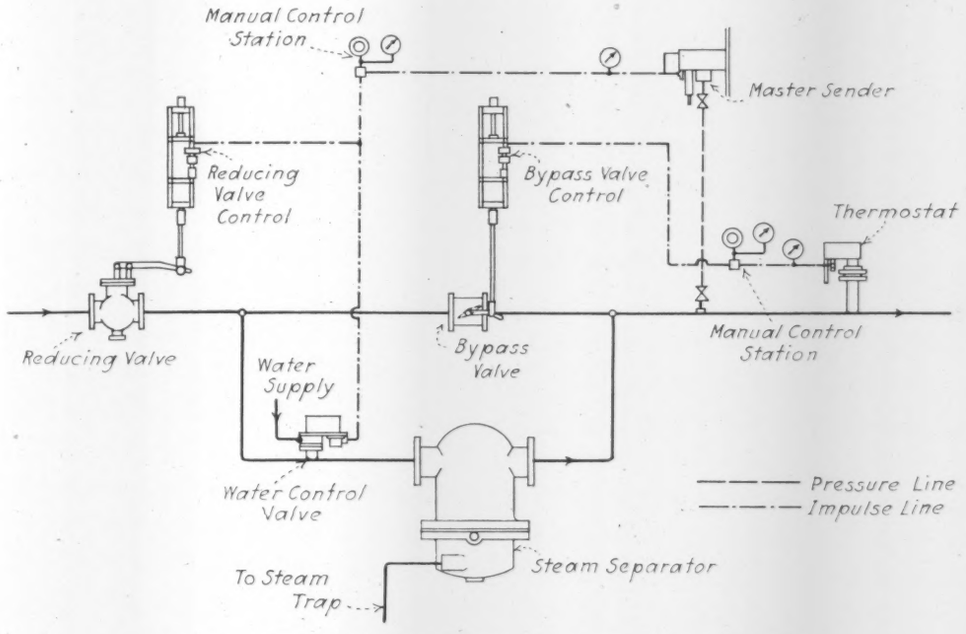



FIG. 9 ANOTHER PRESSURE-REDUCING AND DESUPERHEATING SYSTEM

TABLE 11 PROBLEMS OF DESUPERHEATING—BOILER-WATER CARRY-OVER

| | Case 1 Deposit on strainer following desuperheater | Case 2 Deposit in valve following desuperheater |
|---|---|---|
| | Per cent | |
| Calcium phosphate ($Ca_3(PO_4)_2$) | 52.8 | |
| Sodium phosphate ($Na_3PO_4$) | 1.6 | |
| Sodium sulphate ($Na_2SO_4$) | 5.1 | More than 90 |
| Sodium chloride (NaCl) | | Less than 1 |
| Magnesium silicate ($MgSiO_3$) | 18.4 | |
| Magnesium oxide (MgO) | 2.3 | |
| Iron oxide ($Fe_2O_3$) | 5.2 | |
| Ignition loss | 14.9 | |

TABLE 12 PROBLEMS OF DESUPERHEATING—BOILER-WATER CARRY-OVER

TURBINE DEPOSIT—CASE 1—TABLE 11

| | Per cent |
|---|---|
| Sodium chloride (NaCl) | 2.8 |
| Sodium sulphate ($Na_2SO_4$) | 6.1 |
| Calcium phosphate ($Ca_3(PO_4)_2$) | 6.1 |
| Calcium silicate ($CaSiO_3$) | 1.2 |
| Magnesium silicate ($MgSiO_3$) | 5.0 |
| Silica ($SiO_2$) | 70.5 |
| Iron oxide ($Fe_2O_3$) | 0.8 |
| Ignition loss | 9.5 |

tion absorbs the necessary amount of heat for the maintenance of the desired final temperature in the steam. In both case 1 and case 2, the feedwaters containing respectively 47 and 90 lb of total solids, were used for the desuperheating water, and their total evaporation in the process contributed this amount of total solids to the steam. It is obvious that with this arrangement, only Simonpure condensate should be used for the desuperheating water.

Many cases come up, however, in which condensate is only available with difficulty, or is available only part of the time. The diagram in Fig. 9 illustrates the principle by which this situation is met. By proper control, and following the reducing valve, an appropriate part of the steam proceeds along one path, is brought down to the temperature of saturation by a slight excess of water, is finally separated from the concentrated excess water by appropriate separating equipment, and then is joined with the other part of the steam to which no water has been added. The proportions which flow along the two paths are a function of the final temperature desired.

With this procedure it is not essential that the desuperheating water be condensate, since it is not evaporated to dryness, and since the concentrated water removed in the separator will carry away any solids introduced with it, or for that matter, gained from the steam which it has desuperheated.

Thus it turns out that these boilers which were consigned to Limbo Station, condemned of carry-over of boiler water in the steam, were really not at fault. And certainly, neither the real world nor Limbo Station will shy from a somewhat increased cost of equipment for the greater certainty of the second procedure.

## CONCLUSION

"Nightmare" according to Webster, is a fiend or incubus formerly supposed to oppress people during sleep, and more broadly, is any impression or experience having a similar effect. True to this definition, many of the problems of water conditioning have been nightmares, which could be routed only by the complete understanding of the problems from contact with them under the diverse conditions found in many different plants. Mythical Limbo has served the purpose of a concentration camp of problems and experiences, so that the complete solution of a problem, and its full meaning, could be most simply set down, whether the source of the information happened to be one plant or several. The data, however, are those which have accumulated in our work, and which have been used in the solution of the problems.

# LABOR PROBLEMS *of* BRANCH-PLANT MANAGEMENT

By ALEXANDER R. HERON

DIRECTOR OF INDUSTRIAL RELATIONS, CROWN ZELLERBACH CORP., SAN FRANCISCO, CALIF.

ESSENTIALLY, labor problems are the same in branch plants as in self-contained, single-plant industries. However, there are distinctions of detail, line-and-staff relationships, limitation of powers of decision, and conformance with other company procedures.

In almost every enterprise there are three basic objectives, namely, to serve customers or clients satisfactorily, to provide a fair rental for the capital required, and to provide satisfactory employment to those whose work is needed in the accomplishment of the first two objectives.

Providing satisfactory employment, of course, depends upon satisfactory service to customers and investors. Within this sector are involved exchanges of what employees want from employers for what employers want from employees. Most of the machinery of collective bargaining is merely mechanical routine for stating these wants and satisfying them. In addition, as labor problems must be included certain conditions created by the political manipulations of labor organizers, by the influence of subversive doctrines, by the political affiliations of employers, and by the standards and customs of the area. The complications of fitting the arrangements of a single branch plant into the general policies and organization of a widespread parent corporation must be added to this to complete the problem under consideration.

A branch plant usually has certain decisions made for it, which an independent plant management would make for itself. Certain of these may be passed over rather quickly, as they have little bearing on the daily problems of human relationship. In this class may be grouped the decisions, probably made in the light of the enterprise as a whole, as to the total number of men to be employed, the classes of workers, the numbers in each class, and certain specific positions in the branch organization.

Some of these decisions will be based on the experience in other branches as to the required numbers. The designation of certain specific positions will conform to the type of organization already established for the enterprise as a whole. For instance, it will be thus determined whether each sales branch is to have a credit manager, and each manufacturing branch a technical control manager.

### CONSIDERATION OF WAGE LEVELS

Beyond this group of decisions, which deals generally with quotas, is the more complicated field of wage levels. A parent organization, located in New England or the Middle Atlantic states, must give consideration to the prevailing wage levels in remote areas where the establishment of branches is proposed. Trouble and martyrdom for the branch management of such an enterprise are being invited, if the establishment of a branch in Denver or San Francisco is attempted, without due recognition being given to prevailing wage levels in those cities. Even if the plan calls for the transfer of workmen, accustomed to a 50-cent base rate in some eastern or southern city, to the new branch located where wage levels are higher, that is no answer. It is almost equally unwise to transfer men at high rates to an area where lower rates prevail. As a first premise, each branch is entitled to recognition by its headquarters of prevailing wage levels in the locality where it is established.

A second factor which is frequently overlooked is the consideration of adequate compensation in some form for the better class of employees because of the limited opportunities for advancement which are found in most branches. The "dead end" is reached more rapidly in the branch employing 100 or 500 than in the parent establishment employing 5000. The hope of being promoted from a small branch to a large one, or from a branch to headquarters, sometimes exists. But this does not eliminate the need for recognizing the limitation of opportunities for local advancement, in considering branch-plant wage levels.

Another complication in problems of wage levels arises where the employing company is one unit of an industry-wide association which has standardized wage rates for the industry. This situation exists in the author's industry which, by collective bargaining, has established standard wage rates throughout the Pacific Coast. The wage level thus reached, influenced chiefly by the general wage level in the Pacific Northwest, has been applied uniformly in the three coast states. This is a high wage level in terms of prevailing rates in southern California. If the industry-wide level were based upon a lower wage level, prevalent where most of the industry is located, this would create an extremely difficult problem for the branch located in a higher-wage area.

### EMPLOYMENT DIFFICULTIES OF BRANCH PLANTS

Certain factors under the general heading of employment call for the utmost delegation of authority and responsibility to the branch management. In this group may be included the selection of employees. Given general standards of fitness, the investigation of individuals must be entrusted almost completely to the branch management. Subsequently, in most organizations, the branch management must be held responsible for the instruction and training of the selected employees. The sending of an expert from headquarters, or from an older branch, to train workers on specific jobs, is common practice and sometimes necessary. In spite of the fact that it is customary or necessary, it still creates difficulty for the branch managers. The worker who is trained by a visiting expert tends to believe that he knows more about his job than the line officer under whom he works, the branch superintendent, or the manager.

To carry on effectively the instruction and training of workers under his branch jurisdiction, the branch manager must have at his disposal the principal incentive or reward which induces workers to improve themselves through his instruction or training. He must have an almost free hand in the determinations of promotions within his subordinate jurisdiction.

A last factor under the general heading of employment, seems

Contributed by the Management Division and presented at the Semi-Annual Meeting, San Francisco, Calif., July 10–15, 1939, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

to be one of the most difficult of adjustment. This is the assignment of headquarters candidates to branches. In a large organization, the opportunity to give to a worthy candidate the experience of working in several branches is a valuable one. Sometimes it is essential to his training for future responsibilities. Every time a man is sent from headquarters to become an employee of a branch, he makes life more complicated for the branch management. He is the innocent cause both of resentment and of discontent on the part of those employees who are rooted in the community, where the branch is located.

Where such a headquarters candidate is sent to a branch merely for the purpose of giving him a job, rather than for experience which he will need in his future responsibilities, the practice needs most careful consideration. On broad-gage practical grounds alone, the company which establishes a branch in a given community should recognize its responsibility to place at the disposal of the men in that community as many as possible of the jobs which the branch itself creates.

### COLLECTIVE-BARGAINING PROBLEMS

The fourth class of problems may be grouped under the general heading of collective bargaining. Both the headquarters and branch managements need to be generally familiar with state law and local practices affecting collective bargaining, wherever the branch is located. The branch manager is entirely unprepared for his responsibilities unless he has a thorough grasp of the basic policies and attitudes of the general company management in relation to collective bargaining.

No fixed recommendation is possible as to the degree of responsibility and authority which should be placed in the branch manager for the conduct of collective-bargaining relationships. The essential thing is that this responsibility and authority be definitely determined and known. Experience will show that the wise branch manager will not in any way misrepresent the degree of his authority, in his dealings with local collective-bargaining agencies. The tendency to exaggerate his importance in the eyes of such bargaining representatives invites disaster the first time his attempt to exercise authority, which he does not possess, is overruled by his headquarters. It is almost equally unwise and immoral for the branch manager to understate his authority in the effort to "pass the buck" for certain decisions to some remote executive offices.

While there is no general prescription applicable, it is still true that the best results have always been obtained where authority has been delegated to the branch management, as fully as may be consistent with the organization of the company and its relation to the rest of the industry.

The situation in the Pacific Coast pulp and paper industry presents a case where this delegation is difficult. Thirty-four establishments operate under a uniform labor agreement. This agreement is negotiated jointly on behalf of all the establishments, with two international unions and their fifty-odd locals, which represent the employees in these mills. The actual negotiation is conducted by small committees representing the manufacturers and the employees respectively. More than half of the thirty-four establishments are branches. While each branch manager is present throughout the negotiations and participates in the employer discussions, most of them naturally are not members of the actual negotiating committee.

Thus in the actual negotiations, the desires and prejudices of each plant manager are subordinated not only to the policies of his own company as a whole, but to the policies of the entire industry in the area. At the same time, he has had a voice in determining both those policies. His presence in the negotiations has, in the light of experience, given him a sufficient background for the intelligent conduct of his management duties within the terms of the uniform labor agreement.

Another problem on which a company determination must be made, for most branch establishments, is the degree to which the branch management may participate in local employer organizations. The rise of such employer organizations is becoming more rapid. Whether a New York corporation is to encourage its branch managers in Cleveland and Akron and New Orleans and Seattle to become active participants in local employer organizations is a question which must be answered. The branch organization is not a good citizen of the community in which it is located if it attempts to ride "free" on the vehicle which is being built at considerable cost by native employers in that area. Against this is the fact that a local employer organization might lead a branch management into practices and policies which are seriously different from those of the parent organization. The author has not used the word "principles," because everyone has taken refuge behind this word to justify a refusal to do some things to which he objects on purely practical grounds. But it is a practical truth that concessions, made as part of a local interemployer program by one branch of a large organization, might have embarrassing results when they become known to employees and managers who are in other branches.

Closely related to the problem of local employer organizations is the necessity for adequate equipment for local branch managers to accomplish the prompt and local adjustment of grievances. This includes grievances which are peculiar to the branch plant itself and grievances for which local adjustment machinery has been set up by various employers. It includes the more serious type, where the desires of the local employees, or the demands of strong local unions, conflict with the general practices of the corporation in other places.

The fine line between centralization and decentralization, which must be drawn in connection with each of the problems mentioned, leads to the fifth general subject, that of leadership and morale. The labor problems of branch-plant management will never be solved on paper. They will never be mechanized either in terms of union agreements or beautifully printed statements of company policy and manuals of procedure. They will be solved only in terms of personality of the branch management.

This factor is the first and the last in the labor problems of branch-plant management. The degree to which all of the authorities, so far discussed, can be delegated to the branch management, depends on the personal ability of the branch manager. The increased importance of labor problems has created a new standard not yet fully recognized for the qualifications of the branch manager. If he is sufficiently competent, not only in purchasing or production or sales but also in matters of human relations, he can be trusted with a high degree of authority. He will exercise it with the necessary flexibility, without disregarding the interests of the company at large, its policies, or the problems of its other branches.

If a parent organization expects to receive adequate value for the salary paid to its branch manager, it must dignify and support him to the greatest extent possible. It must permit him to conduct his daily responsibilities in such a way as to merit the respect of his employees, his local competitors, and the labor and employer organizations with which he is in contact.

In this connection, the author cannot refrain from pointing out the harm which frequently results from the unintentional depreciation of a branch manager by the attitude of a visiting executive. The attempt to impress subordinate employees with

the superiority of headquarters in general, or of the individual visiting executive in particular, is an injury to the interests of the company as a whole.

Again, related to this feature is the very important responsibility of the branch manager to integrate the affiliations and attachments of his employee personnel to the employing company as a whole. With a certain type of personality, a branch manager can build up a spirit of attachment, or what is commonly called loyalty, on the part of employees to the local establishment and to him personally. He has fallen short of his duty if he fails to integrate this local morale into the larger spirit of unity, the unity of the company as a whole. The attempt to accomplish this "company consciousness" through such media as the general house organ issued by headquarters to the employees of all branches is frequently misguided. Without depreciating the value of common reading material for all employees of the scattered units of a large company, the building of company consciousness depends much more upon the personality, intelligence, and adaptability of the branch manager himself.

### PACIFIC COAST PECULIARITIES OF BRANCH-PLANT MANAGEMENT

Some labor problems of branch-plant managements on the Pacific Coast are peculiar to this area. Many Pacific Coast branches have their parent organizations in far-distant sections of the country. They are living in an atmosphere of labor relations, community thinking, and political leanings vastly different from that of Wall Street or LaSalle Street.

In general the working personnel with whom they must deal has a greater degree of independence, greater aggressiveness, than workers in other sections of the country. In general, they are hiring and supervising employees who are more definitely of American nationality and character than is true in Boston, or New York, or Detroit.

They are in contact with other employer executives who are principals in their own right, and who generally have the same characteristics of independence and aggressiveness which characterize workers in the area.

With few exceptions, their Pacific Coast locations are such that working conditions, organization practices, and wage levels are dominated by some outstanding industry or industries: oil and airplanes in southern California, packing and shipping in northern California, lumber, pulp, and paper in the Northwest. These are only a few examples.

Influencing every problem of labor relations on the Pacific Coast is the fact that the major industrial areas are around seaport cities. The tragic experience of maritime labor relations throughout the last five years has created problems which probably cannot be comprehended by representatives of management in the inland cities. Out of this maritime experience have grown such peculiarities as coast-wide strikes, coast-wide unions, coast-wide or industry-wide employer organizations, coast-wide arbitration, intensified jurisdictional strife, issues of hot cargoes, and coast-wide boycotts and many other problems.

Combining the general labor problems of branch-plant managements and the peculiar color given to some of those problems by Pacific Coast conditions, there is justification in urging that any establishment, planning or maintaining a Pacific Coast branch, give primary attention to the labor problems of that branch. The headquarters-staff agency dealing with labor problems can well afford the cost of an intensive survey, at the location of each of its branches, of all the factors which have been mentioned. It cannot afford to be unfamiliar with such factors as the degree of union organization in the locality, inter-union conflicts, prevailing wage levels, collective-bargaining practices, employer organizations, state labor laws, and workmen's compensation provisions. It cannot expect to justify its investment unless it places the management of its branch in the hands of a man whose personality, tact, and judgment can be supplemented with the maximum of authority and responsibility. It cannot lightly justify its location in a field where the local customs and practices are antagonistic to the basic labor policies of the parent company.

### BASIC ELEMENTS OF INDUSTRIAL RELATIONS

Local responsibility for labor problems in branch plants has a bearing on what is probably the basic element in future industrial relations. The stage of debating the acceptance of collective bargaining has been passed. The debate now concerns the problem of efficient operation under some of the handicaps of collective bargaining. The road ahead for employers leads past some areas which progressive industry must explore quickly.

The first is the area of recognizing that employees and their unions must be considered as a single entity. The union must be considered as a democratic grouping of employees. No one knows better than Pacific Coast employers that some unions are no such thing. But they never will become the true expression of the minds of the employees until it is made clear to them that they should be and can be just that.

Another is the area in which employers will not only accept collective bargaining wholeheartedly but recognize it as a possible asset.

The next and most important is that area of thought which lies beyond collective bargaining, and which some call collective planning. In this area, in the democratic organization of employees, there lies the possibility of restoring some of the values of the old personal relationships. These values will not be restored by the destruction of collective-bargaining principles and technique, or by a return to the so-called independence of the individual worker which made for industrial autocracy. They will come back when the implications of antagonism, conflicting interest, and compromise, which are inherent in the very words "collective bargaining," have been erased.

In the farthest field of collective planning, there will be an exchange of the facts of business and production problems, of living conditions, and of productive ideas. Managers and employees together will plan on meeting their mutual responsibilities. Instead of meeting to bargain and haggle over wages and hours, overtime, and grievances, more frequent meetings will be held to discuss accident prevention and sales quotas, housing facilities and production costs, company finances, product quality, and customers' complaints. In other words, the comprehensive task of serving customers, stockholders, and workers will be planned.

It is obvious that this desirable and constructive relationship cannot exist between corporation headquarters and the president of the international union; between the general manager and New York and the local union in St. Louis; between the Board of Directors in Chicago and the employees in Oakland, Calif. It can exist only on the basis of day-to-day contacts between local management and local employees or their representatives.

To make any contribution toward the solution of labor problems in general, or its own labor problems in particular, branch-plant management must be personalized. Its problems and its contacts are fundamentally personal. The responsibility for dealing with them must be personalized in the local management. All this presupposes a local management personally competent to merit the necessary delegation of power from headquarters and personally competent to win the necessary confidence from employees.

# CONTROL EQUIPMENT *for* *High-Pressure* OIL *and* GAS WELLS

By HERBERT ALLEN

CHIEF ENGINEER, CAMERON IRON WORKS, INC., HOUSTON, TEX.

SINCE the first 10,000-ft well was drilled in 1931, 211 tests have gone below 10,000 ft of which 41 were drilled during 1937, and 145 during 1938.[1] Of the 10,000-ft holes drilled in 1938, ninety one were in the Texas and Louisiana areas. During the last four years, the average well depth all over the world has increased approximately 10 per cent. In the Texas and Louisiana Gulf Coast region, using depth of holes as an index, average working pressures have increased nearly 20 per cent on new wells, during the same period.

In view of the substantial activity in drilling deep, high-pressure wells in the Texas and Louisiana Gulf Coast region, it is of interest to examine the design of some of the control equipment used in this area, with particular reference to well completions requiring equipment tested to 10,000 lb.

### AVAILABLE EQUIPMENT TAXED TO CAPACITY

The general problem was brought sharply to the attention of manufacturers and operators with the completion of Stanolind Oil and Gas Company's Candelari No. 1, in Green's Bayou area, near Houston, Texas, in October, 1936, at 4850 lb recorded pressure.[2] Since the depth of approximately 8000 ft indicated a normal bottom hole pressure of only about 3500 lb per sq in., the oil fraternity was presented with an outstanding example of what might be expected in deeper wells. Fortunately for the operators, the equipment used at that time, while forced to operate at the test pressure, or in excess thereof, held during attempted blowouts, and control was established.

Parallel development of the Old Ocean Field in Brazoria County, Texas, demonstrated to engineers and operators the pressing need of higher test equipment and new technique of control.

Very few manufacturers were in the field at that time with 10,000-lb test equipment. One valve manufacturer was starting production on a 10,000-lb welded bonnet valve, but the casing-head and control-equipment builders were not on the market with such materials, except in isolated cases for very special jobs. It might be well to mention that one retarding factor was the absence of flange data and gasket design, a work which the American Petroleum Institute was just initiating. The use of threads, particularly on larger diameters, was considered impractical and much thought was being given to the metal-ring joint for flanges (a type of joint which had been used with success). However, so great were the variations in design, it was only after a tentative agreement had been reached by the committees of the American Petroleum Institute that the way was cleared for interchangeable high-test flanged vessels. This work has been well done, however, and the industry is now in possession of a set of standards which represents a real achievement.

### INCREASED USE OF FLANGED STACKED CASING HEADS

By 1936, the use of flanged stacked casing heads had increased considerably. The introduction of high working pressures led to the application of this design as a solution to the high-pressure problem. Fig. 1 illustrates two designs of this type head. (Reference is made only to the flanged stacked structure, as the method of suspending and sealing the casing to the heads varies with manufacturers.) Fig. 1(*b*) is a standard casing-head arrangement, while Fig. 1(*a*) shows the method of attaching a tubing head of the ram type.

In practice, for example, a three-string setting might be worked out with series-600 (2000 lb working pressure) flanges on the surface string; series-900 (3000 lb working pressure) flanges on the intermediate string; and the tubing head so designed that, after the oil string is supported in the stack, series-900 bolting would apply to an area small enough to take a 10,000-lb test, with all parts above series 1500 (5000 lb working pressure). In nearly all cases, this has made the use of series-1500 flanges greater than 6 in. nominal size unnecessary. The longer strings of casing have led to increased development of slip-type suspension with, in most cases, auxiliary welding further to prevent leakage.

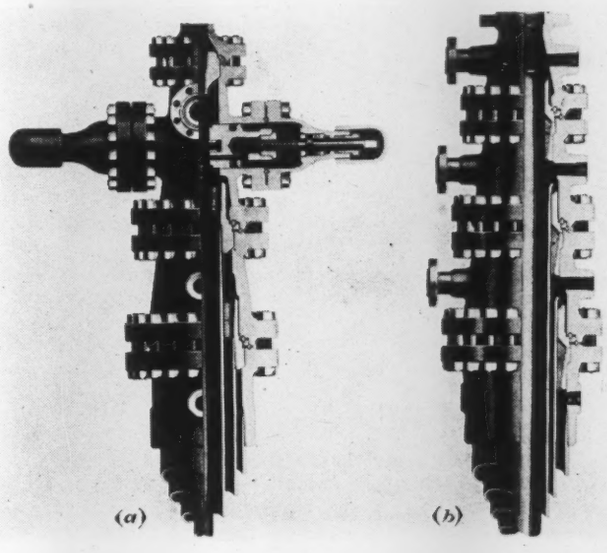



FIG. 1 FLANGED STACKED CASING HEADS

### SIMPLICITY REQUIRED IN SETTING PRACTICE

To explain the necessity of increased simplicity of setting practice, it is only necessary to consider the case of one well drilled in the Texas Gulf Coast. This well was out of control January, 1937, and finally shut in with 2200 lb pressure on a $^3/_4$-in. choke. The well

Presented at the Spring Meeting of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS, New Orleans, Feb. 23–25, 1939.

[1] "Volume of Deep Drilling Surging Upward Rapidly," by Warren L. Baker, *Oil Weekly*, vol. 92, Jan. 30, 1939, p. 58.

[2] "5000-Pound Gas Pressures Controlled in Gulf Wildcat," by Neil Williams, *Oil and Gas Journal*, vol. 35, Nov. 5, 1936, p. 40.

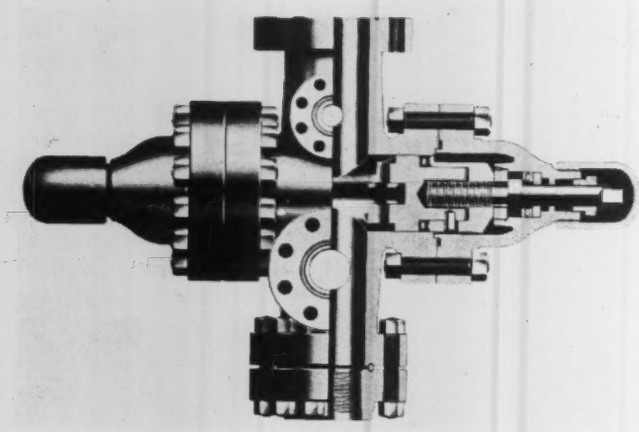


FIG. 2 RAM-TYPE TUBING HEAD

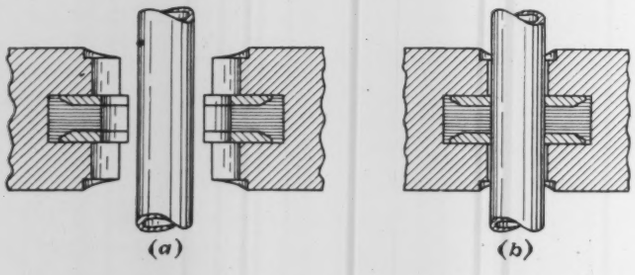



FIG. 3 RAM-PACKING ACTION

eventually killed itself and was redrilled and reset at 9278 ft depth, in October, 1938.[3] When washing was started and the mud weight dropped to 14 lb per gal, flow began and within a few hours showed a shut-in pressure of 6300 lb. Here an abnormal bottom hole pressure was a constant threat. Obviously, once this flow started, there was time for only the simplest and most positive of operations to complete the setting.

Necessity has thus led to the use of setdown-type (anchor) tubing packers, which only require lowering the tubing to a point determined before washing starts. The use of the ram-type tubing head is advantageous, since control of the tubing and well pressure is offered at all times, and the final setting, whether in the rams or above, may be made quickly and securely with all the control equipment in place. In the case mentioned, the presence of mud in the flow was a serious threat to the safety of the completion, as it was necessary to change chokes every few hours for several days until the flow cleared up. The operation of the control manifold valves under such trying conditions was extremely difficult.

[3] "Control Equipment at Sun High-Pressure Bay Shore Well," by Neil Williams, *Oil and Gas Journal*, vol. 37, Nov. 10, 1938, p. 41.

### DESIGNING A RAM-TYPE TUBING HEAD

At this point, it would be well to consider the design problem in a ram-type head. Referring to Fig. 2, the device consists essentially of a flanged cross, with a cross bore larger than the vertical bore, and a pair of rams so placed as to be moved readily by screws to a closed position about the tubing or drill pipe. A complete shutoff is obtained by placing packing across the face of the rams, continuing it longitudinally along the sides and up over the top.

Aside from the problems involved in moving the rams to the closed position, and in designing a body with sufficiently small deflection or straining under pressure to permit the packing to function, there is the highly critical problem of designing a packing that will hold securely. Obviously the most difficult point to pack is the area around the pipe since there are many complicating factors.

The size of pipe is subject to mill tolerances on outside diameters, the surface is rough, and it is essential that the seal remain unbroken while the pipe is moved and rotated. The solution may be studied in Fig. 3. A deep groove in the face of the ram receives an oil-resisting-rubber or Neoprene packing which projects from the face of the ram and has, integrally, a pair of equally projecting plates at the top and bottom of the slot. It is now clear that, when the plates touch each other as the rams move together, the rubber is confined, as may be observed in Fig. 3(*b*). Additional forcing of the rams together sets up a pressure in the rubber as a function of the closing effort applied, which not only permits establishing a pressure in the rubber greater than that to be retained from below, but forces the rubber into a tight seal with the pipe, regardless of the condition of the surface, and permits the maintenance of this pressure as the movement of the pipe wears away the rubber. The volume, defined by the diameter of the

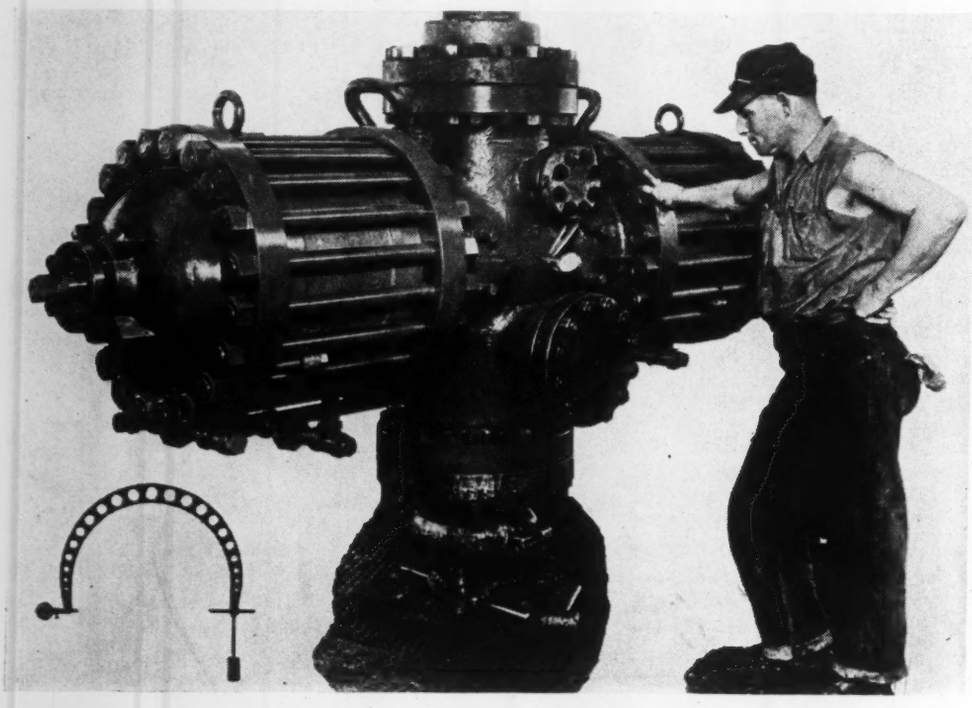


FIG. 4 LARGE DRILLING HEAD WITH SPECIAL EXTENSOMETER

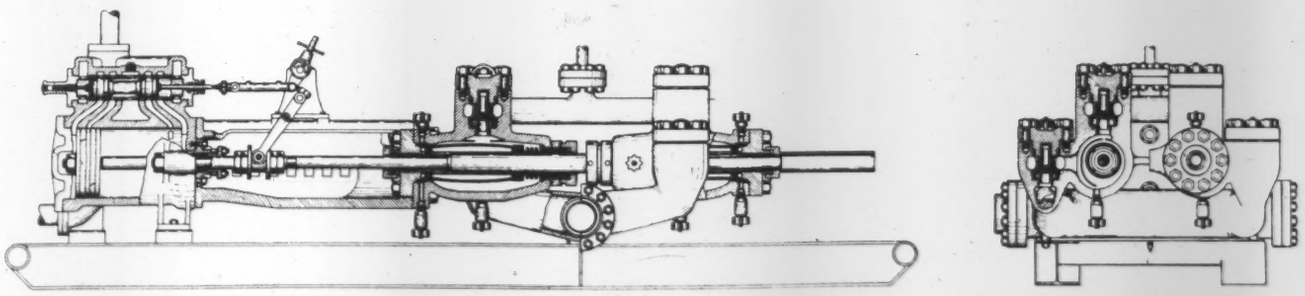


FIG. 5 HIGH-PRESSURE SLUSH PUMP

ram, the packing height, and the initial projection, is capable of being used up in wear while a tight seal is maintained. Due to the fluidity of rubber under pressure, the face packing pressure is distributed throughout the entire packing system and a complete seal is maintained.

In the face of varying requirements as to connections, the body becomes a rather complicated casting due to outlets above and below the rams and the inherent cross-type construction. Cylinder-design formulas based on yield stresses are of little value, as the design of bodies is a problem of strains. The design is made, not to a stress, but to a deflection. In many cases the stress is absurdly low in order to hold the deflection to a safe figure.

### CHECKING DEFLECTION IN DRILL-HEAD TEST

Fig. 4 shows a large 12-in. 6000-lb test drilling head being checked as a routine part of the final pressure test. A micrometer frame carrying a dial gage is fastened at the point of greatest deflection, where the cross bores intersect. Readings before, during, and after this test pressure is applied, constitute a sure check on the casting condition. When it is considered that a total deflection of 0.040 in. is observed on this body at 6000 lb, it is clear that variations in physical properties, as yield strength, ductility, and soundness, may show up as a permanent set. Together with pressure tightness, this test is most important.

Due to the necessity of providing so many combinations of outlets, particularly on tubing heads, a method has been developed for making standard welding preparations in these bosses and welding interchangeable long-neck flanges in place.

FIG. 6 HIGH-PRESSURE SLUSH-PUMP CASTING AFTER CLEANING

### PRESSURE EQUIPMENT FOR TREATING WELLS

Along with the high-pressure casing and tubing control equipment, the immediate and urgent problem of a source of pressure to use in killing or treating high-pressure wells after completion has presented itself. Cementing trucks are available, but their ability to build up pressures to, say, 5000 lb and move a considerable volume of fluid at that pressure is very limited. Accordingly, one pump manufacturer received, and executed, a commission to build a pump capable of moving at least 100 bbl per hr of mud-laden fluid at 6000 lb, with a steam pressure of 350 to 400 lb per sq in. The unit was to be able to pick up fluid and discharge it at a single stage, although in most cases it was contemplated supplying mud fluid at the suction under low pressure.

A previously proved design was incorporated. Referring to Fig. 5, a steam piston actuates a plunger of the center-packed type between two rubber sleeves. The space between the sleeves and the plunger contains water, so that the entrance and withdrawal of the plunger is transmitted as an expansion and contraction of the sleeves to the mud surrounding. Obviously, the plunger and rod packing is relieved of the abrasive action of the mud. With hardened plungers and high-grade packing, this scheme is very satisfactory, as the sleeve is forced to expand only slightly to accommodate the full displacement of the plunger and will, therefore, last for a very long period.

Designing the pump involved a great many problems. A monotype steel casting of such design as to be susceptible of proper feeding, and with wall sections related to prevent shrink holes and porosity, was difficult to lay out. Fig. 6 shows the rough casting which, with gates and risers, required 13,600 lb of steel, and cleaned, weighed 7078 lb. A conventional steam end was used. A steel cradle was built to lend rigidity to the structure.

The principal design problem, aside from the casting and power provision, revolved around two conditions. The friction generated at the packing would be absorbed as heat by the water in the sleeves and, since the rubber acted as an insulator, some escape for this heat had to be provided. In earlier pumps, water running continuously over the plungers solved the

problem but, in a highly stressed period when operators were worried more about the well and results than the care of the pump, it was feared that trouble might ensue. If the heat is not removed, the water may boil on the suction stroke and vapor binding result. Accordingly, finned tubes were incorporated at the ends of the sleeves, as shown in Fig. 5, to provide heat radiation to the mud which acts as a coolant.

The other problem involved the action of the sleeve. During operation at such high pressures, a break in a connection can and does occur, and extremely fast plunger travel ensues. On such a fast stroke the mud nearest an exit can leave immediately and the mud farthest from the exist is prevented from rapid acceleration by its viscosity and the head loss in the clearance about the sleeve. In such a case, the sleeve, being very flexible and being filled with a low-viscosity fluid, is pumped toward the exit and may be ruptured. In older designs, the problem was intensified by a situation where the mud entered the bottom of the cylinder and left the top. Hence, a continuous climbing occurred as, on rapid stroking, mud entered easily at the bottom and left easily near the top with very little distribution about the sleeve.

To study the action of the sleeve with an eye to keeping the clearance as low as possible (an obvious desire in pumping gas-cut mud), a pump was equipped with a number of feeler plugs, such as illustrated in Fig. 7, and connected to a six-element galvanometer-type oscillograph. In addition, a superimposed 60-cycle timing wave and a position indicator, consisting of resistance contacts which were touched as the rocker arm oscillated, gave a tie-in with time and operation. In this way records such as that reproduced in Fig. 8 were obtained and studied.

As a result, the cylinder design, shown in Fig. 5, was developed. The entrance from the suction is protected by a baffle which opens at the bottom of the cylinder and connects with the discharge valve at the top. An opening in the baffle below the discharge port forms a flow balance. If a plunger moves too violently, some fluid may leave here and prevent the motion downward. Conversely, on a rapid suction stroke, there is an entrance of some fluid at the top of the cylinder to balance the sleeve movement.

The pump was operated satisfactorily on test in the field at 7000 lb per sq in., picking up with a suction lift of 3 ft and delivering 80 bbl per hr.

### OTHER IMPORTANT DEVELOPMENTS

In conclusion, it is regrettable that the limitation of space and time prevents discussion of many more interesting developments. Gate valves and plug valves have made tremendous strides in only the last year, with the evolution of the 10,000-lb test valve a story of its own. In plug valves, particularly, the design of bodies has been approached from the standpoint of body deflections almost entirely, since it is obvious that extremely small strains may cause leakage. It is regrettable, too, that the matter of materials, and the part which welding has come to play, could not be discussed. Witness, for example, the welding of bonnets on 10,000-lb test gate valves and pressure vessels of all sorts; even the most complicated are assembled by this method.

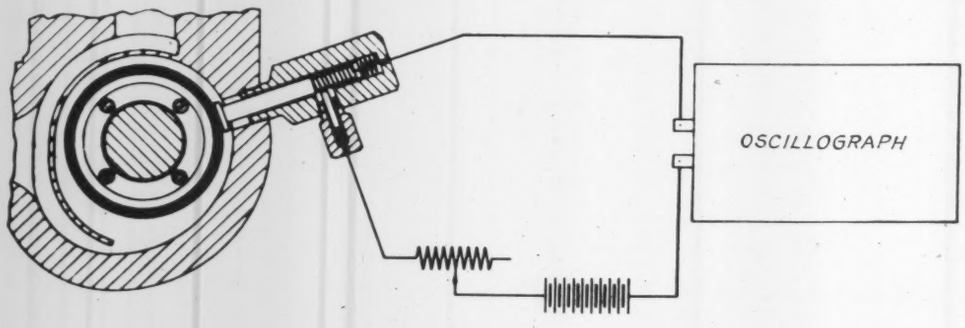



FIG. 7 METHOD OF ATTACHING OSCILLOGRAPH

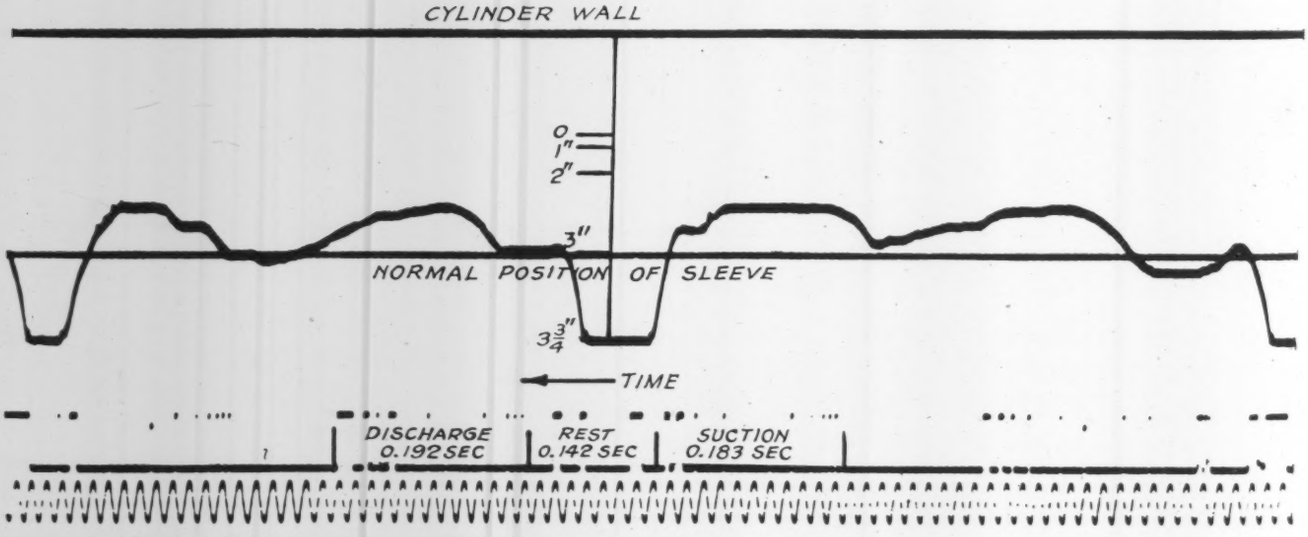



FIG. 8 TYPE OF OSCILLOGRAPH RECORD OBTAINED

# *Photographic Study of* STEAM-BOILER FURNACES *in* OPERATION

By A. A. MARKSON and W. H. DARGAN

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.

THIS PAPER is an attempt to discuss objectively the problem of steam-boiler-furnace photography, using motion pictures prepared by the authors' organization to demonstrate the progress made in this method of analyzing furnace conditions.

The advantages of such illustrative and technical photography are many. It is an aid in the presentation of furnace conditions before a group, because by this means all may be enabled to reach an agreement as to what is observed on the screen or in the photograph. Sometimes three or four screenings are necessary to clear up some moot point. Through the ability to slow down motion by high-speed motion pictures, as in the case of burner-and-flame action, a viewpoint possible by no other means is provided. Similarly, through the ability to speed up action, it is possible to view such phenomena as the agitation of a stoker bed. By using infrared photography, certain details, which may be wholly invisible in operation, such as in slagging bottoms, are brought to light. Nor is it of least importance that pictures of this nature stimulate thought in a field where too much is apt to be taken for granted.

Furnace photography is already quite well established as a means of general demonstration and illustration, being in that respect another offshoot of the general photographic tree. In the combustion field such photography has a legitimate place. Technical interest in the taking of photographs in operating boiler furnaces undoubtedly stems from the stimulating motion pictures shown by E. G. Bailey and by W. H. Dargan at the 1938 Annual Meeting of the Society. Bailey's pictures were presented in connection with his paper[1] and were made in pulverized-coal furnaces. Dargan's were presented as a part of a paper[2] by Mayers and others and illustrated underfeed-stoker fuel beds. Recently, other excellent films have been produced. Owing to their novel and instructive value, such pictures in the future will be produced to an increasing extent and their value for illustrative purposes will become more generally recognized.

Though technically furnace photography shows robust signs, scientifically it is yet in its earliest infancy, in spite of the fact that, in related fields, especially that of internal-combustion engines, much has been accomplished.

In producing illustrative furnace pictures, the first step in this type of photography, the qualities provided in the modern emulsions and equipment aid the work of the photographer and excellent results accrue almost as a matter of course.

In the second step, that of making pictures of technical worth, more difficulty is encountered. The photographer must have the discriminating eye of a combustion technician. His apparatus must be more than usually versatile. Slow motion, accelerated motion, different emulsions and filters, water-cooled apparatus, and other devices must come into play. Here the eyes are more than windows of the brain, for the additional photographic eyesight reveals far more than can be observed by ordinary eyesight.

Arriving at the third step, which includes studies of furnace gases, furnace-temperature studies, flame-propagation measurements, and the like, progress becomes painfully slow. The absence of inherently critical qualities, so remarkably achieved by the photographic industry in its standard products, here militates against quantitative usage. Thus, excursions into such a field as sensitometry must be attempted, difficult because such subjects confront the power-plant engineer but seldom. No road to the facile engineering use of the photographic process in quantitative measurements seems yet to be open. However, it is safe to predict that further progress in this field will be made by engineers as well as by laboratory workers.

## CAMERA EQUIPMENT

The equipment necessary to produce acceptable furnace photographs ranges from the very cheapest of amateur cameras to the rather expensive outfit of the professional. For making still pictures, the 35-mm miniature camera is preferable because of its all-metal construction and because practically every available film emulsion seems to be made in this size. For motion pictures, the same range of equipment facilities is available. The cheapest amateur cameras made in both 8- and 16-mm standard sizes will make satisfactory pictures within their limitations.

The authors use a 16-mm Ciné Kodak Special camera in their work. This camera can be operated at the rate of 8, 16, 32, and 64 frames per sec. The rate of 16 frames per sec is the standard for normal screen projection. In addition, it will expose one frame at a time, which is accomplished by means of an electric release control. This control can be adjusted to operate from 4 frames per sec to one frame every 6 sec. The frames may also be time-exposed. It has many other features found on professional equipment such as ground-glass focusing and an adjustable shutter opening. Interchangeable lenses, ranging from wide angle to telephoto, are available. With all these adjustment features, the apparatus nevertheless is remarkably rugged.

## HIGH-SPEED MOTION-PICTURE CAMERA

High-speed motion-picture photography is of great technical interest in the visual analysis of motion. Workers such as Edgerton have succeeded in carrying the number of frames exposed per second to very high values, in some instances,

[1] "Modern Boiler Furnaces," by E. G. Bailey, Trans. A.S.M.E., vol. 61, 1939, pp. 561–576.

[2] "Progress Report on Fuel-Bed Tests at Hell Gate Generating Station, 1937–1938," by M. A. Mayers and others, presented at Annual Meeting, A.S.M.E., Dec. 5–9, 1938; not published.

Contributed by the Fuels Division for presentation at the Joint Meeting of the Coal Division of The American Institute of Mining and Metallurgical Engineers and the Fuels Division of The American Society of Mechanical Engineers, Columbus, Ohio, Oct. 5–7, 1939.

according to reports, as high as 100,000 pictures per sec. It should be understood that the devices for making these exposures being of a laboratory nature are inherently not applicable to furnace work because they depend for their operation upon stroboscopic illumination furnished by an electric-discharge lamp. Such stroboscopic illumination is not possible in the furnace since the furnace itself must furnish the necessary light.

Recently, a camera has been developed by the Eastman Kodak Company and the Electrical Research Products Company which is capable of exposing a standard roll of film with a speed of as high as 2500 frames per sec. In this camera, which is remarkably simple in construction, the intermittent film motion and shutter are replaced by a rotating prism which in effect causes the image to stand still on the continuously moving film strip. The camera does not run at constant speed, the actual frame speed attained being measured by simultaneous exposure of a special electric clock. At top speed, 100 ft may be run through this device in approximately 2 sec, the resultant film taking 4 min to screen at normal speed.

Since this camera has considerable possibilities in studying the powdered-coal furnace, the authors have recently acquired one and are beginning to use it for this purpose. No auxiliary optical device which appreciably cuts the lens speed of *f*2 is permissible, but it is obviously not required for the few moments that the camera has to be exposed to the heat.

### CAMERA SUPPORT

While the camera may be held in the hand and must often be so used, one soon learns that pictures taken this way lack steadiness. The first fine point of photography therefore is the use of a tripod. Because of the time required to set it up, usually followed by the discovery that it could be moved into a much better position if it were not for some pipe or boiler column in the way of the legs, the ordinary tripod is an unmitigated nuisance. Fig. 1 shows a tripod, built as a carriage of welded

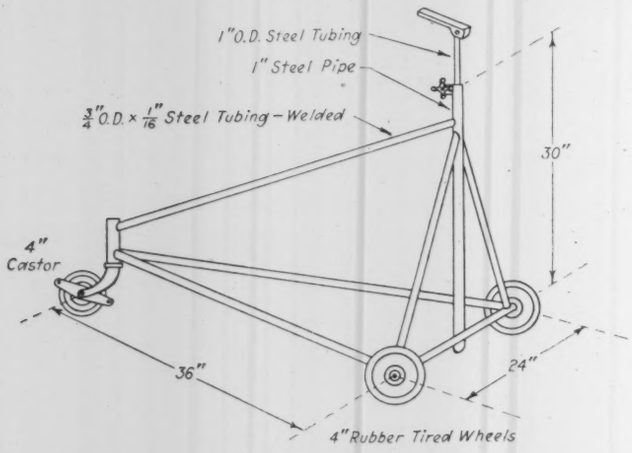



FIG. 1 PYROSCOPE TRUCK

steel tubing, upon which the camera and auxiliary equipment may be set and wheeled very quickly into position. Under most circumstances, it is readily portable. Fig. 2 shows the authors' field setup for making motion pictures.

### THE PYROSCOPE

Protection of equipment becomes a serious matter in working around the furnace. Whereas the simplest exposures may be made by subjecting the camera directly to the furnace for a few seconds, if allowed to remain in intense heat for any length of time, the equipment would be destroyed very quickly. On

FIG. 2 MOTION-PICTURE-CAMERA EQUIPMENT USED BY AUTHORS

stoker-fired units, it is often desirable to expose, over a period of some hours, a series of single-frame pictures which, when projected at normal speed, shows the motion of the fuel bed so speeded up as to be readily observable. For example, some films, made by exposing a frame every 3 sec, when projected at the rate of 16 per sec, show in 1 min of screen time 48 min of stoker action. From results already attained, the authors have also been encouraged to use this method in studying the manner in which slag builds up in the furnace.

In other instances, something better than random aiming of the camera is desired, requiring protection of the machine and its operator. These difficulties have been overcome by using an auxiliary water-cooled-lens system, the optical part of which was built by the Bausch and Lomb Optical Company. A complete description of this instrument, called the pyroscope, may be found in an article by Duncan and Levin.[3]

Fig. 3 shows the pyroscope schematically. Optically, it consists of the equivalent of two telescopes placed objective to objective with the result that the image is transferred without magnification from the collecting lens to the eyepiece lens. The camera lens is placed at the exit pupil. A diaphragm is provided at the proper point in the pyroscope so that the effective aperture of the system may be varied, without the necessity of specially designed camera objectives, to permit instrument maximum aperture equivalent to *f*12 when used with a 1-in. camera lens. When used with the pyroscope, the camera (any type of which may be used) is set at infinity. The exposure required, when used in this manner, will vary approximately with the square of the focal length, giving a great advantage in this respect to short-focal-length lenses.

The advantages of this device in prolonged-exposure work are considerable. Further, and of great importance, it permits taking pictures through very small openings. It would seem, even for visual observation, that an air-cooled device of this sort has a very definite field of usefulness. The present limita-

[3] "The Pyroscope," by Duncan and Levin, in an early issue of *Photo Technique*.

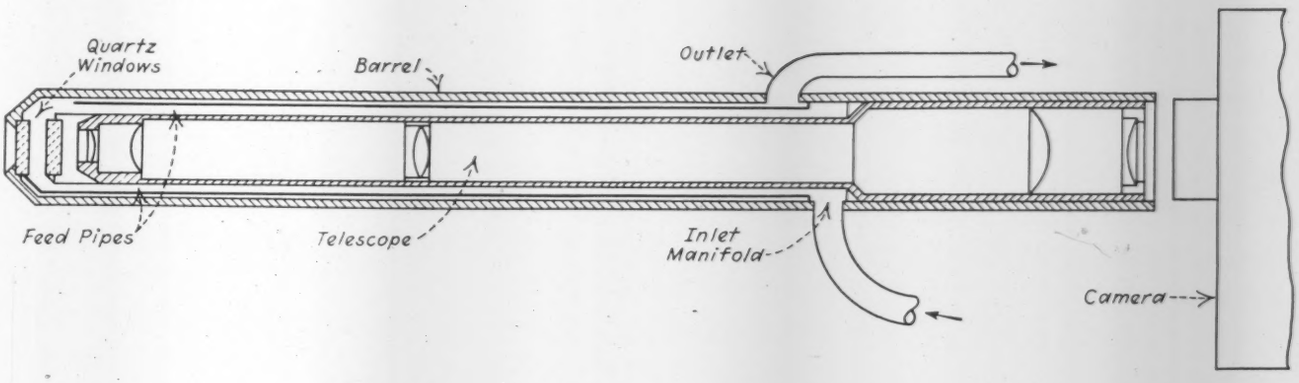



FIG. 3 SCHEMATIC ARRANGEMENT OF PYROSCOPE

tions are not serious. They are, principally, lack of portability, which will be overcome in a subsequent air-cooled device, and a slight loss of definition which must be accepted.

### FILTERS AND EXPOSURE

Photography through filters is often desirable, any of several types being acceptable, such as those satisfactory for ordinary photography. For technical and for scientific work, filters may become very important. The authors have found the Wratten (Eastman) filters[4] in *B* glass among the best for this work, as the transmission characteristics are without doubt the most reliable commercially obtainable in this country. However, being made of gelatin, they are somewhat perishable. Satisfactory glass filters are made by the Jena Glass Works. Their characteristics are also well known and are published in a bulletin[5] which is available from the manufacturer.

Exposure in the furnace is a matter of experiment. The use of a photoelectric exposure meter of the Weston type is to be recommended as an auxiliary, although the readings and film speeds given for ordinary work are quite useless. The following somewhat unscientific procedure is justified for work of a technical character. Using a certain emulsion and filter and a miniature camera, a systematic series of exposures is made at as many different furnace locations as possible. Because of the fact that shutter speeds are not usually very accurate, only two or three standard ones are selected, the principal variations in exposure being secured by change of lens opening. At the same time an exposure-meter reading is taken. Apparent Weston readings of over 5000 are by no means unusual. However, by cutting a fiber cell-mask, the maximum range of the standard meter may be increased by a factor of 5 or 10 for the brightest locations, the factor being determined by exposure with and without the mask to an identical source.

Upon development, the negatives are sorted according to quality and the poor exposures discarded. The light which has acted upon the various negatives is inversely proportional to the square of the *f* number and directly to the time of exposure *T*. The ratio of the two, $T/f^2$, is tabulated with the exposure readings for all good negatives and plotted against Weston readings. Such a curve may be used in future work with the particular exposure meter, filter, and emulsion. By this method, the authors have been able to secure as many as 25 good negatives from a roll of 36 which were exposed under widely differing conditions. After some experience, with the same furnace units, correct exposure should no longer be a problem in ordinary work.

### PHOTOGRAPHIC EMULSIONS

In considering photographic emulsions and their properties as they are applied in combustion studies, certain technicalities unfamiliar to the mechanical engineer cannot be avoided. Fortunately, amateur photography has become so popular a hobby as to serve as a bridge to understanding.

There are two properties of films which are of distinct interest, emulsion speed and sensitivity to light of different wave lengths. In order to consider these intelligently, the following definitions[6] are given.

*The Photographic Spectrum.* The color of light is defined by its component wave lengths. The convenient unit of wave length is the Angstrom which is $10^{-8}$ cm. Blue light is of shorter wave length than red. The human eye is sensitive to blue light as far as 4000 A. Shorter wave lengths than this lie in the invisible ultraviolet. Photographic plates and glass lenses will detect ultraviolet to about 3000 A. Going from the blue-violet to the red end, the eye perceives wave lengths in the region of 5000 to be green. From 5500 to 6500 it receives the stimulus of yellow to deep orange. At 8000 A the color is darkest red, already invisible to most eyes. Beyond 8000 lies the infrared, fast becoming of technical importance because it is principally heat radiation. Photographically, the infrared

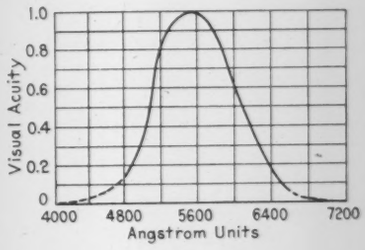



FIG. 4 STANDARD CURVES OF EYE SENSITIVITY

ends at 13,000. Technically, no plates are available beyond 12,000 A. Working beyond these ranges is mainly a spectroscopic and bolometric problem. Fig. 4 is a standard curve of eye sensitivity which indicates the shortcomings of the unaided eye compared with the photographic plate.

*Color Temperature and Wave Length.* The classical laws of black-body radiation state that the intensity of radiation is proportional to the fourth power of the absolute temperature and that the wave length of maximum intensity varies inversely

[4] "Wratten Light Filters," Bulletin published by Eastman Kodak Company, Rochester, N. Y., 1938.

[5] "Jena Colored Optical Filter Glasses for Scientific and Technical Purposes," Bulletin published by Fish-Schurman Corporation, New York, N. Y., 1938.

[6] "Dictionary of Applied Physics," by Richard Glazebrook, Macmillan, London, 1922–1923.

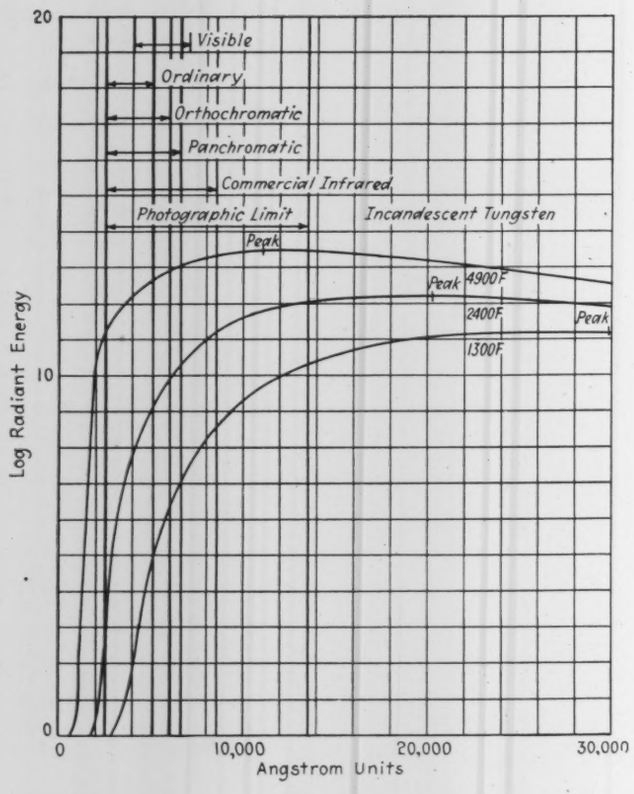



FIG. 5 CURVES OF ENERGY DISTRIBUTION

as the absolute temperature. These laws are considered to approximate the conditions in a furnace. Color temperature is defined by the second of these, the law of Wien, which, with its constants, is expressed by saying that the wave length of maximum intensity in Angstrom units

$$\lambda = \frac{51{,}800{,}000}{T}$$

where $T$ is expressed in degrees F abs. It follows that the maximum intensities for these temperatures lie at the following wave lengths:

| Degrees F | Angstroms |
|---|---|
| 500 | 54000 |
| 1000 | 35500 |
| 1500 | 26400 |
| 2000 | 21100 |
| 2500 | 17500 |
| 3000 | 15000 |

*Energy Distribution.* The theoretical distribution of energy from a black body is given by Planck's law which states that the energy at any wave length $\lambda$ in a thermodynamic cavity (black body) at temperature $T$, is proportional to

$$\frac{K_1}{\lambda^5(e^{K_2/K_3\lambda T} - 1)}$$

where $K_1$, $K_2$, $K_3$ are constants involving the velocity of light and the basic quantum and gas constants.

Such curves of energy distribution, using data from the International Critical Tables, have been plotted in Fig. 5 for color temperatures of 4900 F, 2400 F, and 1300 F. The temperature 4900 F is approximately that of a tungsten photographic light. The log of the energy has been plotted against Angstrom units because the log energy is proportional to photographic effect as will be demonstrated. The limits of sensitivity of photographic emulsions are indicated on the plot. From these theoretical curves, two conclusions are apparent in a semiquantitative manner.

First, the photographic process does not extend far enough into the red spectrum to make it readily utilizable for scientific work in furnaces.[7] Second, for much technical work, the use of highly red-sensitive emulsions is indicated.

Two such emulsions are Kodachrome and infrared-sensitive black-and-white films. Kodachrome is a standard product which reproduces ordinary objects in natural color. In the furnace, the effects rendered by Kodachrome are very beautiful and, because of visual color differentiation, are superior to the usual panchromatic black-and-white film to which its spectral sensitivity corresponds. However, since the processing of this material must be done by the factory, a week usually passes before the results are known. Kodachrome is made in two types, for daylight and for artificial-light use. The authors prefer the daylight type because its excess red sensitivity seems to be desirable for display purposes.

On the other hand, infrared-sensitive film, while giving a black-and-white result, is considerably more sensitive to the red and can be processed by any laboratory. The authors' experience indicates that the use of this film is more satisfactory for work in the most difficult parts of the powdered-coal furnace, namely, the intense-burning areas. Furnace haze seems to be penetrated fairly well by these films. A most able discussion of infrared photography has been given by Clark.[8] In buying infrared films, the user should not lose sight of the fact that some so-called "infrared" films are really only hyperpanchromatic and have little or no sensitivity in the invisible spectrum.

*Speed* is that quality of an emulsion which gives the desired photographic result with the least time of exposure.

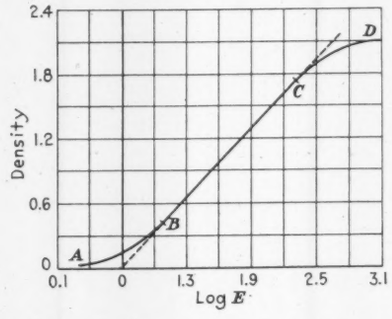



FIG. 6 CHARACTERISTIC DENSITY CURVE OF AN EMULSION

*Latitude* is that quality which allows the same final result to be obtained with variations in exposure. If a photographic emulsion is successively exposed to light strengths of known relative intensities and then developed, the densities produced may be measured by a densitometer. When plotted against the log of the exposure, these densities show the characteristic curve of the emulsion. Fig. 6 is such a curve. Density is defined as the log of the ratio of incident to transmitted-light intensity, the logarithmic function arising from the consideration that the amount of light transmitted through a dense medium diminishes in accordance with the compound-interest law. No image results from exposure below the threshold value $A$. From $A$ to $B$ density increases along a curved line. From $B$ to $C$ the plot is a straight line. From $C$ to $D$ the density

[7] "Furnace Photography," by A. A. Markson, *Combustion*, June, 1939, pp. 24–26.

[8] "Photography by Infrared," by W. Clark, John Wiley & Sons, Inc., New York, N. Y., 1939.

is again a curved function as *D*, the point of maximum blackness, is reached. The straight portion of the line is the photographically useful one for reproducing objects in original contrast. Thus density is plotted as a function of log exposure.

If the various ratios of the incident to transmitted light on the plate (which correspond to various portions of the object photographed) are in the same ratio as the corresponding brightness of the object, then they are in the same ratio as the exposures on various portions of the plate, since exposures vary with brightness. Obviously, this condition holds true only on the straight portion of the curve, which is the region of correct exposure for the particular emulsion and light source. The projection of line *B-C* to the abscissa of zero density gives an exposure called the inertial value. This inertial value is the basis of the *H* and *D* system of speed ratings. The Weston system uses the straight line *B-C* as its basis, when the material is given standard development, which is quite important. From this it may be seen that, in the furnace, latitude may have several meanings.

In photographing a nest of boiler tubes of narrow brightness range, the exposure places all the densities on a small part of the straight line and it is apparent that considerable variation in the exposure is permissible. On the other hand, when the subject is the same group of tubes, with a burner flame in the

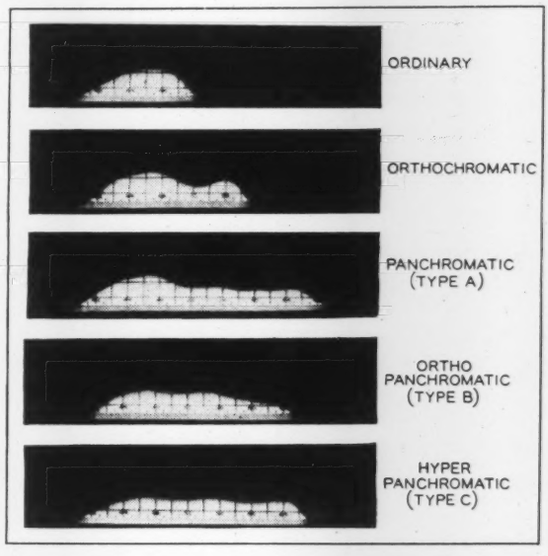



FIG. 7 WEDGE SPECTRA FOR VARIOUS FILMS AND PLATES

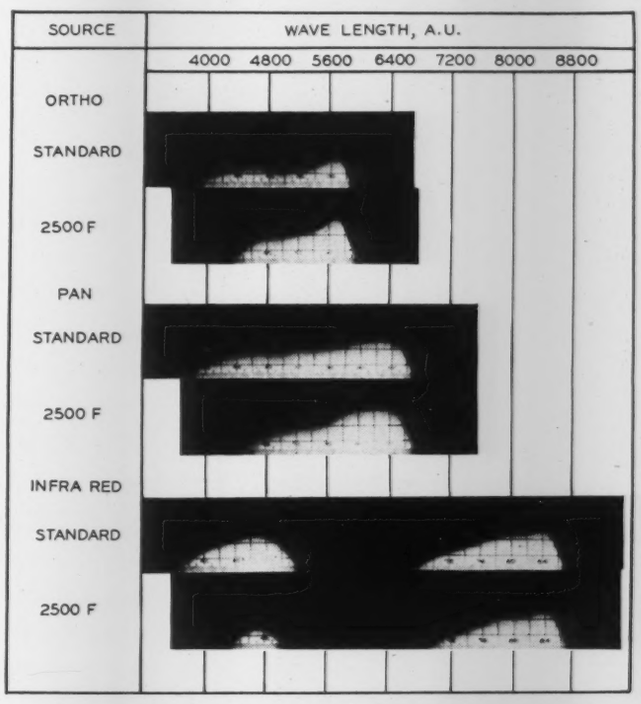



FIG. 8 WEDGE SPECTROGRAM OF FILMS USED BY AUTHORS

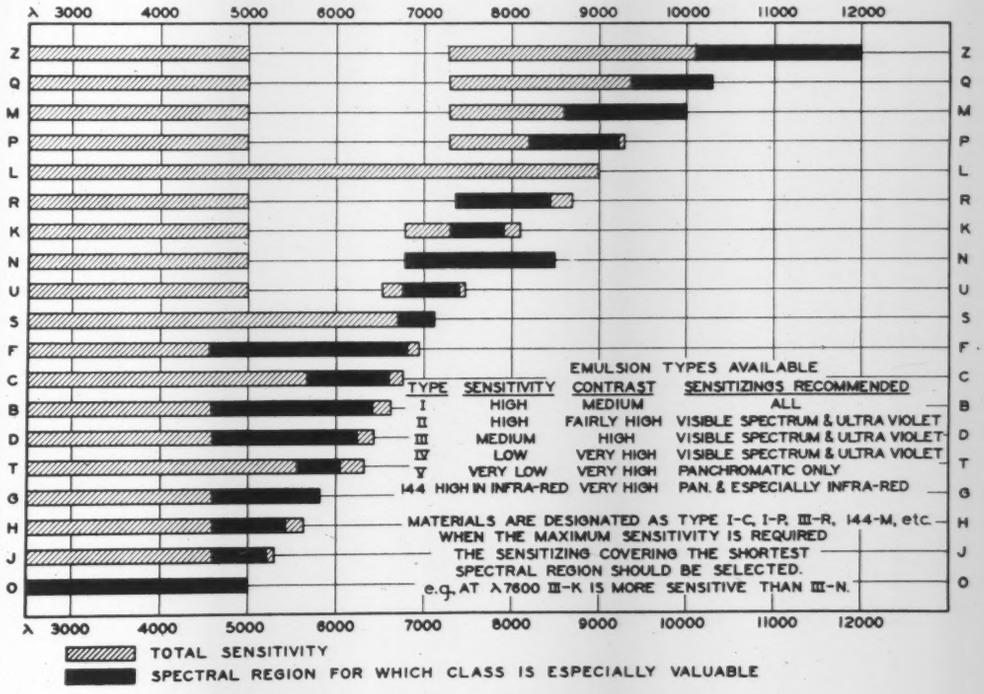

λ 3000 4000 5000 6000 7000 8000 9000 10000 11000 12000
Z Q M P L R K N U S F C B D T G H J O
EMULSION TYPES AVAILABLE
TYPE SENSITIVITY CONTRAST SENSITIZINGS RECOMMENDED
I HIGH MEDIUM ALL
II HIGH FAIRLY HIGH VISIBLE SPECTRUM & ULTRA VIOLET
III MEDIUM HIGH VISIBLE SPECTRUM & ULTRA VIOLET
IV LOW VERY HIGH VISIBLE SPECTRUM & ULTRA VIOLET
V VERY LOW VERY HIGH PANCHROMATIC ONLY
144 HIGH IN INFRA-RED VERY HIGH PAN. & ESPECIALLY INFRA-RED
MATERIALS ARE DESIGNATED AS TYPE I-C, I-P, III-R, 144-M, etc.
WHEN THE MAXIMUM SENSITIVITY IS REQUIRED
THE SENSITIZING COVERING THE SHORTEST
SPECTRAL REGION SHOULD BE SELECTED.
e.g. AT λ7600 III-K IS MORE SENSITIVE THAN III-N.
TOTAL SENSITIVITY
SPECTRAL REGION FOR WHICH CLASS IS ESPECIALLY VALUABLE

FIG. 9 DIAGRAM OF SENSITIZINGS AVAILABLE IN KODAK DRY PLATES

scene, the brightness range more than fills the straight line and the latitude is zero. If, however, a red filter is used to screen off the visible light, it affects the flame more than the tubes and again tends to bring the complete exposure within the straight-line region. With information such as this available, one might think that scientifically correct exposure would be a matter of routine. Unfortunately, a consideration alone of the effect of the difference in color temperature and radiation characteristics between the furnace and the laboratory sources, which are used to produce such curves, dispels this hope. But such information, however, may still remain a most valuable guide.

Of considerable interest is the conclusion borne out in practice that, in the furnace, Kodachrome film is of somewhat superior latitude to black and white. This is of course the reverse of standard photographic ratings. The explanation of this is that true color rendition has little meaning in the furnace and therefore Kodachrome has the well-known advantage of a multicoated emulsion with respect to latitude.

### THE WEDGE SPECTROGRAM

If a light source, such as a furnace or fuel bed, is examined by a spectroscope, the spectrum produced is practically continuous. The photograph of this spectrum is of course a rectangular figure in which the length of the spectrum depends upon the dispersion and the height is simply in proportion to the length of the slit in the instrument. If along the length of the slit, a dark glass wedge were placed, then a photographic spectrum would be produced in which the ordinates would be proportional to the strength of the light at any wave length and the sensitivity of emulsion. Such a diagram is called a wedge spectrogram and obviously is an excellent measure of emulsion color sensitivity when the source is at a standard color temperature. Fig. 7 illustrates such wedge spectra for various types of films and plates manufactured by the Eastman Kodak Company. Fig. 8 is the wedge spectrogram of the infrared 16-mm and other films which the authors use. These were made with standard tungsten and 2500-F tungsten light. Fig. 9 is a diagram of the various sensitizings available in the dry plates made by the Eastman Kodak Company for scientific purposes.

For qualitative purposes, the wedge spectra may be superposed on the energy-distribution curves of Fig. 5, and show very nicely how responsiveness of emulsions to various color temperatures may be gaged. Indeed this procedure coupled with advanced sensitometry may well be considered a basic quantitative technique. Not the least important practical conclusion is a reemphasis of the fact the daylight and tungsten speed readings are not even comparative with different types of emulsions for furnace work.

### ACKNOWLEDGMENTS

In conclusion, the authors wish to acknowledge a rather heavy debt to the various publications[9] of the Eastman Kodak Company and to Dr. H. C. Staehle of the Kodak research department. Figs. 7, 8, and 9 also are reproduced by courtesy of the Kodak Company. Thanks are also extended to James Duncan, research physicist in the authors' department, for valued suggestions and to Warren Master who supervised the construction of apparatus such as the water-cooled telescope housing and the tripod described. Finally, the authors wish to acknowledge the encouragement and furtherance of this work by Ward F. Davidson, director of research, Consolidated Edison Company of New York, Inc., and affiliated companies, who among other things suggested the use of the auxiliary water-cooled optical system referred to in the text.

[9] "Photography of Colored Objects;" "Fundamentals of Photography;" and "Plates for Astronomy and Spectroscopy," published by the Eastman Kodak Company, Rochester, N. Y., are suggested as valuable references in studying the subject of technical photography.

ILLUMINATION FOR A FOUNTAIN

(One of a series of three groups of "illuminating drums" on the island in the Lagoon of Nations, which combine with fire, water, and sound, in nightly displays at the New York World's Fair. There are 580 drums in all, each containing a powerful mercury and an incandescent lamp. They can be manipulated by remote control so as to provide many startling and beautiful effects.)

# TECHNICAL MUSEUMS *in* SOVIET RUSSIA

By H. PHILIP SPRATT

LONDON, ENGLAND. ASSOCIATE A.S.M.E.

WHEN one reviews present conditions in the Soviet Union, it must be borne in mind that this vast country and its people are still in the throes of industrial reconstruction, such as that exemplified in the *Sharikopodshipnik* works at Moscow, or the automobile works at Gorky. New museums under the Commissariat of Public Education have been developed in line with the plans of socialist reconstruction, and hence we find that museums of technical science have, since the Revolution, increased in comparison with those of the fine arts; and this in spite of the fact that the latter have also been enriched with treasures from the private collections which were nationalized and placed at the disposal of the public.

Revolution and antichurch museums have become a feature of Soviet conditions; the former constitute a vital weapon for emancipation of the toilers, and to help them overcome the last survivals of capitalism. The antichurch museums must be considered as the natural reaction from former conditions in priest-ridden "Holy Russia" whose churches and cathedrals are now, for the most part, used as museums or warehouses. The cathedral of Saint Isaac, for example, which dates back to the time of Peter the Great in 1710, is now used as an antichurch museum, and the main dome is utilized for the suspension of a Foucault pendulum of 320 ft, to demonstrate the rotation of the earth. Church worship is neither forbidden nor supported; but in actual fact, most of these Soviet people seem to worship the natural sciences in preference to an orthodox church.

Most of the museums which I visited were under efficient state administration, but were still housed in the beautiful but unpractical old czarist palaces which had fallen into sad disrepair since the revolution. The standard of museum technique was the more to be admired, when one considered the difficult material conditions under which it was maintained; these will, however, soon be eliminated, for the Soviet Union is a land of reconstruction, and new museums on the most modern lines are now in course of erection. The educational movement in which these museums form such a vital factor assumes fantastic proportions when considered in calm retrospect here in conservative old London; but out there, in that land of fresh ideals, bold experiments, and heroic achievements, this Londoner must have become Soviet-minded. As we enter these Soviet museums, we shall notice first a red-draped portrait of Lenin, and then a red-draped portrait of Stalin; we shall have to accustom ourselves to these red-draped portraits, lest their overabundance should prove tiresome.

### HOUSE OF TECHNICAL PROPAGANDA, LENINGRAD

The old capital of the czars is not a town of slow historical development like Moscow, but was built in the course of the last two centuries, to a coordinated artistic plan from the start.

FIG. 1 MODEL OF DNIEPROSTROY WATER-POWER PLANT

The foremost architects of Europe collaborated, and the result has been a harmonious architectural ensemble such as one finds also in Paris. There are fine broad boulevards like the old Nevsky Prospect, wide, open squares and noble structures, such as the Admiralty and the Winter Palace (with its superb collection of Rembrandts) on the banks of the Neva. This is one of the most beautiful cities of northern Europe, and constitutes the scientific center of modern Soviet Russia. One feels here the throb of industrial enterprise, and a visit to the enormous Stalin works was a revelation to me, in contrast to the depression of central Europe. The museums, which form such a vital factor in socialist reconstruction, have developed new methods suitable for worshipers of technical science; and the foregoing title of the exhibition about to be described, should forewarn the reader of its character.

This was the first museum which I visited in the Soviet Union. It is housed in a palatial old structure on the Nevsky Prospect, about five minutes walk from the enormous Europe Hotel in which Intourist made me so comfortable, and almost opposite the public library.[1] Inside the vestibule, the main staircase leads directly to the first floor where a special exhibition was assembled to show the technical achievements of the first Five-Year Plan and the latest developments of scientific research in the Soviet Union, with a practical demonstration of television. In the entrance hall were models of power stations; for example, the enormous Dnieprostroy water-power plant (Fig. 1), with nine turbines for a total of 810,000 hp, which supplies electric power within a radius of 200 miles; also the Volkhov

[1] "Libraries for Scientific Research in Europe and America," by H. Philip Spratt, Grafton and Co., London, 1936.

water-power station, completed in 1920, the first in Soviet Russia.

The electrical equipment on exhibition was all of Soviet manufacture: oil-immersed circuit breakers, transformers and rectifiers, remote control, electric spot and seam welders (shown in operation), filament lamps, radio valves, automatic telephone stations, domestic electrical appliances. The mechanical departments included: railroad and tram material, textile machines, automatic capstan lathes, pneumatic road drills, automatic nail makers, saw sharpeners, and other machine tools. The models were not enclosed in cases, but open for the public to handle, to their obvious detriment. There was also a collection of precision instruments, even vernier scales, micrometers, and standard measurement rods—all of Soviet manufacture. In another room were sound-film machines, shown in operation, and delicate scientific instruments, such as chemical balances and microscopes. The heavier industries included some effective pictures of the enormous tractor works at Kharkov, and new foundries for the production of stainless steel. Well-constructed airplane motors were on exhibition, and models of prime movers built in the local Russky Diesel works.

Particular interest was attached to a proposed speed train, to run on balls instead of wheels. The balls were of steel, about 2 m (78 in.) diameter, with electric motors inside, and covered with rubber. These ran in a concave track of reinforced concrete; the vehicle was suspended below the center of the balls, and was therefore stable. The motive power was electrical three-phase, with overhead transmission, and the vehicles were streamlined. The invention thus combined the three best speed characteristics of the monotrack electrical propulsion, and an airplane-like construction. Models have been tested near Moscow, and speeds of 70 km per hr attained; from these results it has been calculated that speeds of 270 km per hr (about 170 mph) could be realized with an actual train.

The lecture room was provided with demonstration models, mounted in compact movable screens; each was covered with a shutter, so that the lecturer could concentrate attention on one model at a time. The machines could be dismantled, and the parts handed around for members of the audience to examine. The whole auditorium was mounted on wheels, and ran from one exhibit to another. Most of the rooms were spacious and well suited for exhibition purposes. There was little of historical interest; the museum was rather like a trade show, but without advertisement, since it was the outcome of state (and not private) enterprise. The main point of interest, and of wonder, was this technical development of men who had been from the start ill-trained for such work. It was evident that the Soviet workers are now able to manufacture for themselves the heaviest machines and even the most delicate scientific instruments. Three hours in this technical museum were all too short.

### STATE AGRICULTURAL MUSEUM, LENINGRAD

This museum, now under the supervision of the Commissariat of Public Education, is an establishment for scientific research and popular instruction on the collective farm schemes. Founded soon after the accession of Alexander II, this venerable institution is a credit to the (now) much-abused czarist period. The main entrance faces the Fontanka Canal and the Summer Gardens on the banks of the Neva, and the ornate architecture bears traces of the French cultural influence which prevailed here in the "bad old times" of capitalism. The museum has an available floor area of close on 10,000 sq m (107,000 sq ft) for exhibition purposes. The collections include about 27,000 exhibits, from the Soviet Union and abroad, and are classified into four main departments.

The natural sciences are treated in their relation to farm work, and considerable attention is devoted to weather phenomena. Well-labeled exhibits show the practical use of rainfall recorders and barometers, and instruments to measure the speed and direction of the wind. There are also illustrations of various cloud formations, with an indication of the weather to be predicted from them in each case. The remarkable development of collective farms in the Soviet Union is impressed upon the visitor, with statistical charts on the walls. Rural welfare is shown in numerous farm structures and "fireproof" wooden houses for the peasants, sectioned in parts; the traditional Russian stoves are still used in most cases, but insulated from the wooden portion of the structure. The botanical department contains an extensive herbarium of useful plants; some of the breeds were peculiar to Russian conditions. Soil science had received careful treatment, and various artificial manures and other chemical preparations of Soviet manufacture were exhibited, with their effects on crop production. The utilization of marshland and meadows for cattle fodder was also included.

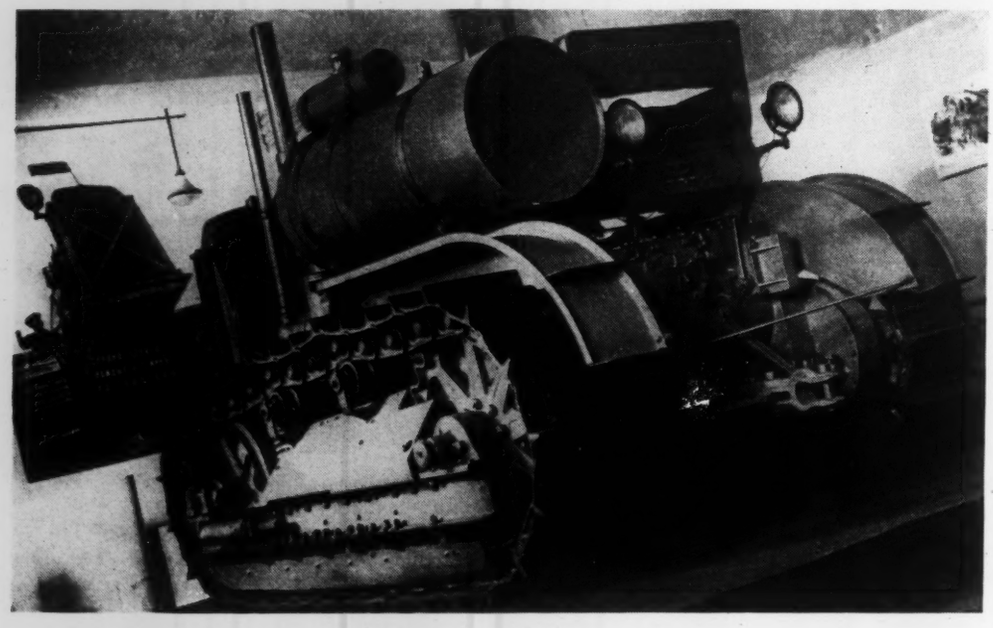


FIG. 2 SOVIET FARM TRACTOR

In the fruit-culture division are some remarkable collections of realistic wax fruit models, exhibited in desk and wall cases, all of them labeled for reference. More than three hundred different kinds of apples alone are represented. The leaves and blossoms of fruit trees are illustrated in colored pictures around the walls. The diseases and pests of cultivated plants are also shown, and the most practical and effective methods

for their treatment. The new annex of the museum contains a separate department of forest exploitation and the timber industries. The various breeds of horses and other cattle on the Soviet farms are represented in their natural proportions, with fine specimens of taxidermal art; these stuffed animals are mounted on wooden baseboards, but not encased. One corner is devoted to sheep, and another to cows; skeletons are used to indicate their anatomical structure. Around the room are wall cases in which some hundreds of cattle specimens in miniature are exhibited; all of them are well labeled. The installation of modern abattoirs and mechanized dairies are also shown, which include an electrical device to milk cows in about one quarter of the usual time.

FIG. 3 STATE POLYTECHNICAL MUSEUM, MOSCOW

The labeled specimens of chickens and ducks form a most comprehensive collection of their kind, and are mounted in showcases with shelves on three levels. Some notable research work has been carried out with ultraviolet radiations, both on the chicken food and on the chickens themselves. The vitamin-D content of the seed is thus increased, while the chickens so treated are healthier, better-developed, and (from the commercial point of view) much more productive.

Various forms of incubators are exhibited. The division of apiculture occupies another hall, and is also developed on both scientific and practical lines. Sectioned models show the construction of various forms of beehives; while the numerous desk and wall cases contain modeled specimens of bees to an increased scale, and chemical exhibits to demonstrate how their production depends upon the various plants and flowers to which the bees have access. Some of the most modern devices and machines used on Soviet collectivized bee farms are also exhibited; their practical operation can further be studied in the "live museum" on Krestovsky Ostrov (to be described later). The division of fish culture, sea fisheries, and the whale industries completes this department of the museum.

Most important of all, perhaps, is the department of farm implements and mechanization, which occupies three extensive halls, and has now been extended to include the modern farm tractors (Fig. 2) of Soviet manufacture. The historical collections number more than 700 models of farm implements; all conceivable forms of plow, ancient and modern, seem to be represented. In another hall are the mechanical mowers, reapers, and harvesters. One of the most recent developments on the cooperative farms has been the use of electrical tractors. Two such machines, about half a mile apart, are used to pull a double-ended plow with six cutter to and fro across the fields on a steel cable. In addition to the permanent collections as a means of public education, the museum also holds special exhibitions and courses of lectures. The main auditorium has seats for 500 persons, and is provided for motion pictures; there is also a reserve collection of about 12,000 lantern slides, which can be drawn upon to illustrate the lectures. The reference library of the museum contains about 72,000 volumes, and receives all Russian periodicals within its scope, and most of the important ones from abroad. The reference room was well crowded with readers. The museum issues a periodical report on its activities. Most of the models on exhibition are prepared in the museum workshop, which also supplies other similar institutions, on "mass-production" lines, with educational material. The number of visitors received is said to amount to about one million per annum.

No museum confined to inanimate collections, such as herbariums, stuffed animals and skeletons, models and machines, can ever prove adequate for the representation of farm life and work. Plants and animals in the live state are essential for demonstration purposes, and for this reason the "Zhivoy Muzey" or "live museum" has been developed since 1920 on Krestovsky Ostrov, one of the beautiful islands northwest of the town, which face on the Gulf of Finland. The administrative offices are housed in a former palace of the most decorative architecture, now somewhat faded but maintained in fair condition. The domain of 100 hectares (close to 250 acres) comprises meadowland for the cattle, a "live herbarium," and arable land for experimental crop production. The various cultivated plants and fruit trees are set out in neat plots, and labeled for the purpose of experimental records. There is also an installation for hothouse plants. In the experimental bee farm, the hives are spaced at definite intervals with flower beds around them. This is indeed an ideal farm, and to witness so much methodical work carried out here under peaceful conditions, far from the noise of the town, makes a most pleasant visit on a summer afternoon.

### STATE POLYTECHNICAL MUSEUM, MOSCOW

To experience the full flavor of modern Soviet life, one has to visit Moscow. This is a town of slow and historical development, the same as London. There is contrast—color and shadow, much that is beautiful, and much that is not. The sunset behind the spires of the Kremlin and the onion-like domes of Saint Basil, as seen from the windows of the Novo Moskovskaya hotel across the river, is a view which I shall ever remember. The new Intourist hotel in Gorky Street, a colossal structure of reinforced concrete decorated with red banners, proclaims the ambitious spirit of the modern Soviet Union; contrast is near at hand in the ancient Red Square, the beautiful old Kremlin, and the fantastic little cathedral of Saint Basil. In front of the Kremlin Wall stands the mausoleum of Lenin, massive and austere.

From here, narrow streets lead out in the northeast, and a walk of ten minutes in this direction takes us to the ancient Chinese Wall. On the other side of this, we cross a wide open square; and ahead of us, in the Kitaisky Proyezd, stands the Science Museum of Soviet Russia. This was founded in 1872 as a private enterprise, on the initiative of the "Lovers of

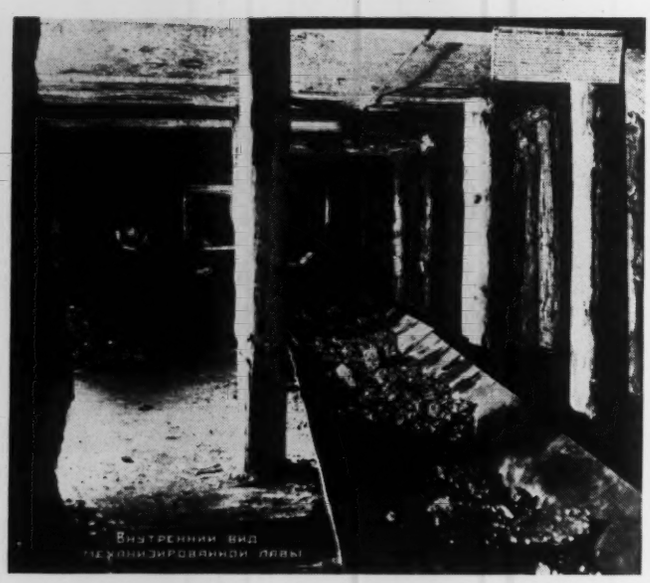



FIG. 4 COAL-MINE EXHIBIT

Natural Sciences" who held a technical exhibition at that time to celebrate the two centuries from the birth of Peter the Great. The central four-storied portion of the structure was completed in 1877, and the three-storied blocks on either side were added later. The most recent extension, that on the left-hand side, was not completed until 1907; but nevertheless it harmonizes well with the older parts of the structure. Rounded arches above the windows form a decorative feature in the architecture, and lend an oriental aspect to the whole (Fig. 3). The museum thus retains some of the charm of old-world Russia, before Soviet modernism, with its severe architecture of reinforced concrete, had come to dominate the scene.

Before the socialist revolution, the museum was a private enterprise with scant material means; it had to depend on private contributions for funds and exhibits, while the lower floor was let out as offices to various commercial firms. In spite of these material difficulties, however, the collections were steadily developed on the lines of the technical exhibition of 1872. After the revolution, the museum was of course nationalized, and it became the "Central Institute of Technical Science" under the administration of the commissariat of public education. In accordance with the ambitious plans of Soviet reconstruction, laboratories for scientific research, courses of public lectures, and classes for school children were added to the museum activities; and the rooms which had been let as commercial offices were reclaimed.

When I visited this museum for the first time, I had the fortune to see a special exhibition entitled "Our Achievements" which demonstrated to the Moscow public the industrial and technical developments which had been accomplished under Soviet administration. At the conclusion of this exhibition in 1935, most of the technical material was absorbed into the permanent museum collections, which now number more than 15,700 exhibits. The name of the museum was altered to "Gosudarstvennuiy Politechnichesky Muzey" at the same time, and a liberal state allocation of 3,750,000 rubles (about $710,000) per annum has since enabled the most ambitious schemes of development to be realized.

Inside the main entrance is an enormous statue of Lenin astride the world, and a booth where publications of the museum are on sale and the small admission fee is paid. The museum is open, except on public festivals, from 11 a.m. to 3 p.m. The floor area amounts to 30,000 sq m (323,000 sq ft), inclusive of administrative offices, workshops, and laboratories; the net area devoted to public exhibition space is about 22,000 sq m (237,000 sq ft) which includes the lecture hall. In contrast to the old-fashioned external architecture, most of the rooms have been redecorated and even reconstructed on modern Soviet lines; for instance, what could be termed the "hall of honor" was comparable in severe plainness with the Lenin mausoleum, and a certain noble effect has been achieved.

For the purpose of scientific classification, the collections are divided into 20 main departments with numerous subdivisions. The department of mineral resources contains an illuminated spherical map of the Soviet Union, about 7 ft diameter, with statistical notes on the output of the various European and Siberian provinces. Sectioned models show how the mines are timbered with props, and how the excavated ores are transported and raised to the surface. The manufacture of iron is illustrated with a realistic model of blast furnaces for 1000 cu m (35,000 cu ft). There are some fine pictures of modern steelworks, while the extraction of copper and the precious metals is also represented. Considerable detail has been devoted to the rare metals and their industrial applications. In a small room (decorated with portraits of Lenin and Stalin) are exhibited the various radioactive earths and luminous compositions. Models in the wall cases demonstrate the extraction of these rare metals, while an exhibit in the center of the room shows how much raw material is needed in the production of a Soviet metal called "pobedit" which is made in the Electrostal works.

The elements of kinematics and the details of mechanisms

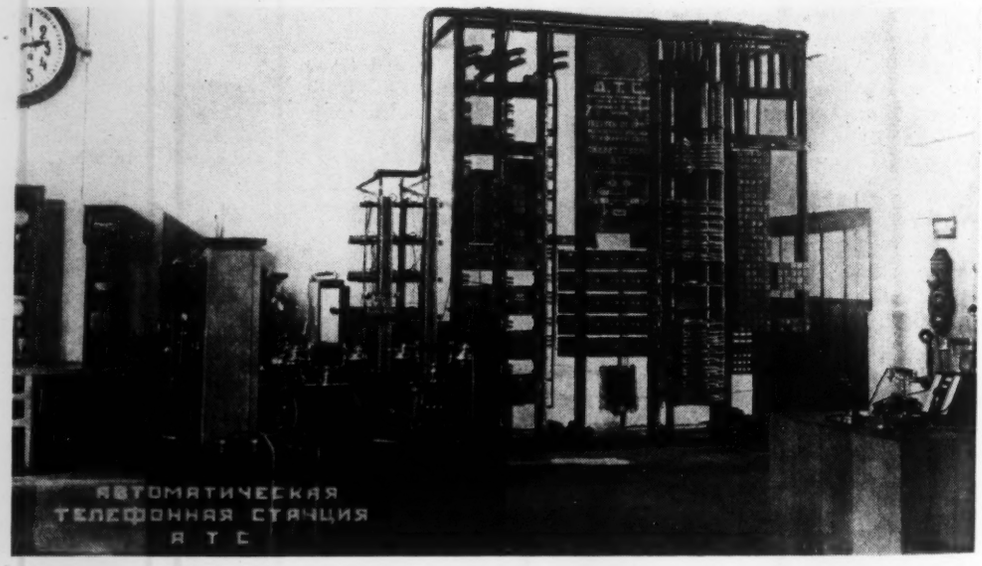



FIG. 5 AUTOMATIC TELEPHONE STATION

are demonstrated in a simple manner with models which the public can operate for themselves, and most of which had suffered in consequence. However, it cannot be denied that reasonable wear and tear of models is well spent on public education. An important section is devoted to the distribution of electrical power. Here was a fine model (scale 1:50) of the dam and 810,000-hp water-power station at Dnieprostroy, which has revolutionized the local industries. Steam-turbine-driven power stations are likewise represented, and the exhibition of electrical machines, transformers, and transmission lines for power distribution occupies a number of rooms. Considerable attention has been devoted to instruments for electrical control and measurement, and to automatic protective devices, such as those produced in the "Svetlana" works, which can be shown in operation. The utilization of electrical power comprises ambitious schemes for electrification of chemical industries and the modest household electric saucepan.

Fuel resources are abundant in the Soviet Union, mineral oil in particular, and their industrial exploitation thus occupies a prominent place in the technical scheme of this museum. One realistic model shows a cross section of the subterranean strata under an oil field, complete with wells and petroleum refineries. Further details of the installation are shown in a diorama. Wall cases around the room contain specimens of the petroleum distillates and refined products. Coal is also important in the resources of the Soviet Union, and some of the cellars under the museum have been utilized for the reconstruction of an actual coal mine (Fig. 4) which when completed will form a most realistic attraction.

The collective farms which form another such important factor in Soviet development are well represented here as in the northern capital already described. There is, however, no "live museum" in Moscow, but particular attention has been devoted to farm mechanization, and some of the powerful tractors (about 320 hp) built in the "Stalin" works are exhibited. The department of chemical industries contains some instructive models of plant the walls behind which are decorated with statistical charts and ascendant curves of production; rubber and artificial silk are both well represented. The department of public works includes plans for the Palace of Soviets, and other ambitious schemes of municipal improvement in Moscow. Other pictures and sectioned models show details of the new Metro (or subway) which has relieved the transport problem in Moscow.

FIG. 6 STALIN AUTOMOBILE WORKS EXHIBIT

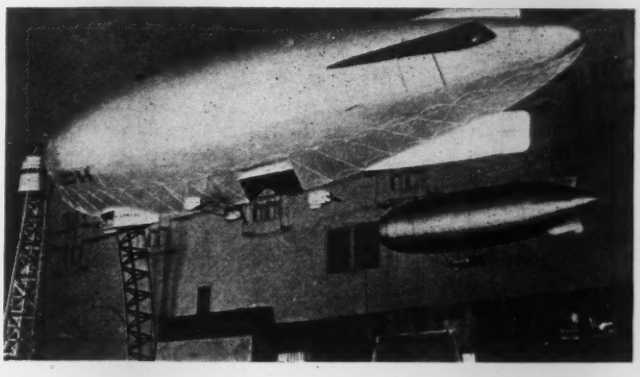


FIG. 7 MODEL OF SOVIET AIRSHIP

The textile and ceramic department has not much of novel interest to offer, but makes, nonetheless, an impressive show of Soviet workmanship. It is confined to the technical aspect with modern automatic looms, machines for the mass production of boots and shoes and bottle manufacture. The electrical communications, however, include the most recent innovations, with an automatic telephone station (Fig. 5) of Soviet manufacture, instruments for sound reproduction, radio, and a practical demonstration of television. Two small cubicles have been erected at opposite ends of the museum, from which visitors can be televised, one to the other in both directions. Fur manufacture receives full treatment due to its importance under Russian conditions, and a comprehensive exhibition has been made of the communal food industries.

The automobile section contains an aerial view of the Stalin works in Moscow. The whole process of mass production is shown in schematic illustrations on the walls (Fig. 6). Motor chassis are exhibited in part section. I had no time to visit these works in Moscow, but was able to make a complete tour of the motor works at Gorky. Soviet aeronautical achievements, in polar exploration, in the stratosphere, and in the more prosaic forms of aerial transport, have inspired an air-minded nation. One of the most spectacular exhibits is the model of a Soviet airship, moored to a model mast which stands about 11 ft from the floor (Fig. 7). Other sectioned models show the internal details of airship construction, while a model of the famous Soviet stratosphere balloon attracts much public interest.

The museum has a small lecture and conference hall with cinema installation, in which courses of illustrated lectures are provided, both for technical students and to meet the popular demand. An exhibition of the inventions of Soviet workmen serves to stimulate local effort in this direction, while a new department for children has been formed on similar lines to that in the Science Museum at London, which I have described elsewhere.[2] Special exhibitions, such as "Our Achievements" which has already been mentioned, maintain public interest; and the records of attendance show about 700,000 visitors per annum, most of them Soviet workers, school children, and students from the technical schools. The educational activities of the museum comprise chemical, electrical, and other laboratories, and a department for historical research. For much valuable information and help in the preparation of these notes, I have to thank Mr. Suitin, assistant director of the museum.

[2] *Journal of The Franklin Institute*, July, 1938, pp. 67–82.

# THE NATIONAL LABOR RELATIONS ACT

By E. ROBERT LIVERNASH

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

AFTER months of congressional hearings, the National Labor Relations Act has not been amended. However, the many controversial issues raised by this piece of legislation remain a storm center of public policy. In the heat of controversy opinions have become crystallized and arguments stereotyped.

As an example of the opinions expressed about the act, consider the statement, so frequently made, that the act is biased and one-sided. If we repealed all biased legislation there would be little left on the statute books. In the midst of such arguments, to give the Wagner Act and its administration the thorough consideration which it deserves may well demand a fresh start. As an aid to a reexamination of the act and the work of the board, Robert R. R. Brooks's "Unions of Their Own Choosing"[1] will be found useful and interesting.

Before discussing Mr. Brooks's book, let us review briefly the salient features of the act. The basic philosophy of the act is expressed in Section 7, which says:

> Employees shall have the right to self-organization, to form, join, or assist labor organizations, to bargain collectively through representatives of their own choosing, and to engage in concerted activities, for the purpose of collective bargaining or other mutual aid or protection.

To give an effective sanction to employees' right to organize and bargain collectively, Section 8 makes it an unfair labor practice for an employer:

> (1) To interfere with, restrain, or coerce employees in the exercise of the rights guaranteed in section 7.
> (2) To dominate or interfere with the formation or administration of any labor organization or contribute financial or other support to it. . . . . .
> (3) By discrimination in regard to hire or tenure of employment or any term or condition of employment to encourage or discourage membership in any labor organization. . . . . .
> (4) To discharge or otherwise discriminate against an employee because he has filed charges or given testimony under this act.
> (5) To refuse to bargain collectively with the representatives of his employees, subject to the provisions of section 9(*a*).

Other sections provide that the representatives of the employees selected by the majority in an appropriate unit shall be the exclusive representatives of all the employees for the purpose of collective bargaining, that the board shall have the power to determine the appropriate unit (company, plant, craft, or other), and that the board may certify representatives for purposes of collective bargaining and order employers to cease and desist from unfair labor practices.

Mr. Brooks has combined effectively an adequately detailed explanation of the provisions of the act, and the principles established through interpretation of the act by the labor board, with an analysis of the criticisms brought against the act. His first four chapters describe "The Board at Work," "The Background" of the act, and the provisions of the act and their interpretation with regard to "Anti-Unionism" and "Collective Bargaining." The last five chapters relate to the broader issues of "Industrial Peace" and "The N.L.R.B. and Democracy," and to the special problems of "Interunion Conflict," "The Unfair Practices of Labor," and "The Board and the Courts." Rather than attempting to condense the entire treatment within the scope of this review, certain sections have been selected as typical of the constructive way in which the general subject has been developed. In particular we shall discuss (1) the board at work, (2) the conflict with the right to freedom of speech, (3) the significance of the majority-rule provision, (4) the question of including in the act certain unfair practices directed against labor, and (5) some criticisms directed against the procedure of the board.

### THE BOARD AT WORK

"The Board at Work" is not a mere description of the procedure of the board. Rather it is a frame of reference necessary for a well-rounded understanding of the board's work. Very few of us realize that only about 5 per cent of the actions brought under the act are carried to some stage of the formal procedure of hearings, reports, decisions, and orders; and of those cases culminating in decisions and orders, we read primarily of those creating court battles of national interest. To identify the work of the board with the relatively few cases prominently headlined in the newspapers does not give us proper perspective. We fail to take note of the 16 per cent of the actions dismissed by the board, the 24 per cent withdrawn by the unions, and the 55 per cent settled by adjustment. We tend to base our opinions on the labor board upon those situations in which the board has had a maximum of difficulty in obtaining adherence to the principles of the act.

Mr. Brooks gives good examples of actions which have been dismissed, withdrawn, and adjusted. Following through these examples leads one to a realization that the big bulk of the work of the board is essentially of a mediatory nature and quite different from the more court-like formal procedure. The many informal adjustments of unfair labor practices and questions concerning representation constitute a phase of the board's work in which a great contribution toward industrial peace is made.

The voluntary adjustments carried out through informal procedure do, however, rest upon a right to organize and bargain collectively greatly strengthened by the act. The right to organize is strengthened particularly by prohibiting "interference," "discrimination," and "domination of a labor organization." Prohibiting interference has meant the outlawing of industrial espionage, individual anti-union contracts, widespread propaganda against unions, and the use of violent union-smashing tactics. Preventing discrimination has been most important in making discharge for union membership or activities an illegal act. Making domination of a labor organization an unfair labor practice forces the employer to refrain from encouraging any particular labor organization. All of these provisions are discussed by Mr. Brooks in his chapter on "Anti-Unionism."

### THE QUESTION OF FREE SPEECH

While the grosser forms of anti-unionism are generally frowned upon by the public and admittedly contrary to the principles of the Wagner Act, there has been much controversy

---

[1] "Unions of Their Own Choosing," by Robert R. R. Brooks, Yale University Press, New Haven, 1939.

One of a series of reviews of current economic literature affecting engineering prepared by members of the department of economics and social science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

over the use of the spoken and written word to influence workers. The argument used is that preventing an employer from saying what he wishes is a violation of the right of freedom of speech and press. Mr. Brooks has done an admirable job in explaining the nature of this issue.

As with most of the conflicts that have arisen over the principles of the Wagner Act, this issue of freedom of speech is a question not of absolute right, but a balancing and definition of conflicting rights. As Mr. Brooks says (page 52):

> The rights of an individual or group to free speech and press are obviously limited by the rights of others. If society decides that pornography is bad for children, it says so in legal form and designates some agency to interpret and enforce the law. The judges may have some difficulty in deciding whether an object is pornographic or artistic, but they are compelled by the law to try to decide. No one seriously questions the judge's obligation and right to make a decision. If one does question this obligation and right, one must oppose the law against pornography and urge its repeal.
>
> For more than a hundred years the courts have been empowered to enforce the doctrines of conspiracy and restraint of trade against unions. The law was as vague as the standards of art and pornography. The judge's background and the circumstances surrounding the case were, perforce, the criteria of decision. . . . No one would question the judge's right to interfere *at some point* with the activity of strikers in using the spoken or written word.
>
> * * * *
>
> If the board were to be restrained at every point where a decision cut across someone's absolute right to free speech, the enforcement of the act among anti-unionists would immediately collapse. The board would be unable to prevent employers from bringing any form of written or verbal pressure to bear against workers' inclination to organize. In every anti-union situation speech and press play an important role. Some speech and some writing must be prevented if the act is to be enforced. It is the board's task to determine at what point it shall modify the right of speech and writing in favor of the right to collective bargaining. In each case it takes all the attendant circumstances into account and if the entire behavior of the employer adds up to a policy of intimidation, as in the Muskin case and scores of others, it orders the employer to cease his policies including those carried out by voice and the distribution of the written word.

This last sentence of Mr. Brooks's deserves special emphasis. If one reads a quotation from a decision of the board which says that such and such a statement constitutes evidence of intimidation, one may feel that the board has gone too far. But the actual situation may be such that the statement is a small and almost negligible part of the evidence upon which the board based its decision. Decisions of the board which involve only a violation of the first unfair labor practice are relatively rare. The vast number of cases involving a violation of the first unfair labor practice also involve violations of other unfair labor practices. And in those cases which involve only a violation of the first unfair labor practice, the evidence taken as a whole will, in the minds of most individuals, amply support the decision. Allow me to repeat that in each case the question is whether "the entire behavior of the employer adds up to a policy of intimidation."

### THE MAJORITY-RULE PROVISION

While the prevention of anti-unionism in its various forms leaves employees relatively free to organize, the board also carries on a very important function in determining the appropriate unit of representation and in determining the "exclusive representatives" of the workers. Many aspects of this phase of the board's work are discussed by Mr. Brooks. The fifth unfair labor practice, requiring employers to bargain collectively, is predicated upon certification of representatives. The conflict of the C.I.O. and the A.F.of L. involves the appropriate method for determining the bargaining unit. But perhaps the most challenging aspect of this phase of the activities of the board is the general principle of majority rule and its relation to industrial peace.

While it is impossible to say whether the Wagner Act, examined broadly, has intensified or diminished industrial friction, the principle of majority rule is a major contribution to the cause of industrial peace. Some of the most severe strikes in the history of the American labor movement have been struggles for recognition. In the past if an employer refused to deal with a labor union, the only course open to the union was to strike. Now we can say, at least in principle, that there is no necessity for such strikes. If a majority of the employees in an appropriate unit desires to deal collectively with an employer, recognition automatically follows. This principle works both ways. An employer may deal individually with his workers if a majority does not wish to deal collectively. Furthermore, a union which strikes for recognition without first availing itself of the opportunities provided by the act will be more and more frowned upon by the public. The establishment of this procedure is a healthy influence. We have a democratic way of determining whether individual or collective bargaining shall prevail.

### OMISSION OF UNFAIR LABOR PRACTICES DIRECTED AGAINST LABOR

Much has been said about the inequity of not including a list of unfair practices directed against labor. Mr. Brooks considers the various suggestions at some length. His discussion divides the proposals as coming under one of three general headings: (1) "assaults on personal and property rights," (2) "the legality of certain types of strikes," (3) "the internal shortcomings of unionism." He then analyzes the various proposals that have been made to see what the likely effects would be. Would it be possible to include certain unfair labor practices which would remedy the internal shortcomings of labor unions, which would regulate or prohibit certain types of strikes, which would prevent assaults upon persons and property? In general, he finds such suggestions as have been made unsuited to the procedure of the board, and untenable in the light of their own objectives.

### CRITICISMS OF THE BOARD'S PROCEDURE

One line of criticism of the board which is difficult for those not legally trained to appraise is that directed against the procedure of the board. Mr. Brooks clarifies these issues in an excellent fashion. He states four characteristics of administrative agencies which apply to the board. They are as follows: "(1) It cannot be enjoined by federal district courts from carrying out its regulatory responsibilities. (2) It is allowed greater freedom in the admission of evidence during its hearings than is generally the case in jury trials. (3) In appeals to the circuit court for relief from the board's orders, the court must accept the findings of the board if supported by evidence. (4) Agents of the board in its formal hearings act in the capacities of both prosecutors and judges."

As Mr. Brooks says: "Each of these characteristics has given rise to attacks upon the N.L.R.B. which have been even more bitter than those directed against other administrative agencies in their time." Particularly has the board been condemned for admitting evidence in a very lax and prejudiced fashion. Yet there seems little justification for this charge. Ample review by the courts is available. If a trial examiner refuses to sustain an employer's objection to the admission of certain evidence, the attorney may take exception to this ruling. This exception is then subject to review by the courts. Not only does there seem to be ample protection through court review, but there are also reasons, holding true for all administrative agencies, for relaxing the rules for the admission of evidence.

*(Continued on page 744)*

# *The* ENGINEER *in* PUBLIC SERVICE

By JOSEPH M. BYRNE, JR.

COMMISSIONER OF THE PORT OF NEW YORK AUTHORITY

DURING the last twenty years, a considerable change has occurred in the character of the problems confronting the engineer and in the conditions under which he labors. The tempo of the change has been accelerated during the latter part of this period rather than decreased. The automobile, the airplane, and the radio, through engineering research, have brought about the development of large industries employing many thousands of persons. These industries in turn have given impetus to the construction of highways, expansion of airway systems, broadcasting chains, and telephone systems. The initial upsurge from the demands which were thus created resulted in a tremendous boom in business and industry. When the bubble burst, a correspondingly exaggerated drop in activity resulted and the search for the causes and cures of depressions was on.

It is the author's purpose to consider the present position and outlook of the engineer in relation to current conditions and to suggest ways in which he may aid in improving them, while at the same time bettering himself.

### PRESENT CONDITIONS CONFRONTING THE ENGINEER

In general, there are three ways in which the engineer affects the economic life of his city or community. As an adviser to a private client, his views directly impress themselves upon individual projects and developments. In the public service, his work influences to a large extent the trend and characteristics of the growth of a state, city, or community. As a part of the engineering profession as a whole, he is expected to express well-considered opinions and to advise in an increasing degree on public policy in connection with public works and related problems.

When engaged by a private client, the engineer is often required to submit not one design but several alternative designs. He is asked to express his views concerning the merits and defects of each. The client is thus enabled to determine the most economic solution of his problem, with the result that a better investment is secured to the greater benefit of all concerned.

In public service the engineer is often responsible to a large extent for the natural tendency to improve conditions of living and to secure a greater appreciation for the aesthetic aspects of community life, as expressed in housing and planning. He is required at times to play an important part in molding public opinion and, at the same time, is required to have a due regard for the taxpayer's pocketbook.

A better and more complete planning of public works is becoming more and more the responsibility of the engineer. The relationship of an individual project, with regard not only to other projects but also to its functions in the public interest and to its competitive aspect with private enterprise, is an increasingly important factor, meriting the most serious consideration of which the engineer is capable. Due to strong differences of opinion, mental confusion and uncertainty, and ulterior motives, public-works programs require the logical and unbiased thinking of the trained engineer.

Between the extremes of collective security and individualism, between government ownership and private initiative, between self-liquidating projects and purely social undertakings of doubtful value, between government spending with mounting deficits and individual time-proved old-fashioned economy, the engineer finds himself and his profession in the most critical position in history. Many old schemes dressed up in new terminology are being tried out and found wanting. A magic panacea for our economic ills has been vainly sought and we are now returning to the old fundamental laws handed down through the ages. Under such conditions of mental and moral distress, the engineer is faced with the responsibility of making recommendations as well as decisions of the greatest importance.

Despite the assertions of some, that the ability to solve problems in the physical sciences does not imply such ability in social and economic fields, the author believes that the engineer's training to think logically and in orderly sequence, to seek cause and effect, and to maintain an unbiased attitude, is a long step in the direction of solving social and economic problems. Furthermore, since the engineer is blamed for the technological advances and the conditions resulting therefrom, he must contribute his efforts to a more satisfactory adjustment of our economic as well as our industrial life and is excellently equipped to do so.

### QUALITIES OF THE ENGINEER

As a citizen who has had the opportunity of higher education, the engineer is in a position to give critical thought and support to measures initiated for the public good. As a result of his education and experience, he is trained in the technique of honest thinking. He analyzes current problems by reducing them to their simplest terms and discriminates between reliable and faulty data. He is trained to distinguish between the possible, the probable, and the actual. A basic contribution of the engineer to society is his respect for the truth and his training in reasoning correctly and cautiously from given premises. The engineer in speaking to the public tends to argue for the "best plan," to tell the "whole truth," as he sees it, partly because of his education, partly from habit, and partly because of his reputation for being logical, consistent, and impartial.

If the energy and ability of the engineer have created wealth and physical comforts, they have also endangered social stability. If the engineer realizes and assumes responsibility for the technological advances, as he has, he must also recognize the dangers and consequences resulting from his work. For every offensive advance in war and industry, a protective defense is soon evolved. For every defect or ill created, a compensating benefit eventually arrives or a superseding improvement eliminates the original complaint. The physician heals, the educator teaches, the lawyer adjusts human relations; but the engineer for his part will be called more and more to direct the mass effort of his race. He is society's indicated master planner, its research worker seeking truth, and the conservator of its natural resources for coming generations.

### PRESENT STATUS OF THE ENGINEER

With the advent of the W.P.A., many agencies and communities took advantage of qualified engineers on the relief rolls. Originally planned to undertake projects of low material costs

Presented at a general meeting at the Newark College of Engineering, Newark, N. J., May 17, 1939, of the Metropolitan Section of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

and of short duration, the W.P.A. developed rapidly into an agency undertaking large projects requiring many months to complete. Many projects were worthy but many more were poorly conceived and not of permanent value. After six years, bargains in engineers from the standpoint of education and experience may be found throughout the country to the great detriment of the engineering profession and the disadvantage of recent engineering graduates who, seeking minor positions, find them filled with men of much longer experience.

Those engineers in positions of responsibility and influence are the ones upon whom rests the task of improving the status of the engineer. It is not enough that they do their own jobs better than ever before. It is imperative that they protect the engineering profession from the demoralizing influences that are reducing it to a position of years ago. Let them stand forth as leaders. The less fortunately situated members of the profession will more than repay such efforts with deeds greatly to the credit of the profession. Those who do lead will themselves acquire greater stature in life's picture.

On several occasions, leaders in industry and finance have said that engineers prepare estimates and reports upon which lawyers capitalize to establish reputations. The engineer has been forced more and more into industrial management and has been compelled to assume new responsibilities; but many times someone else has assumed the leadership derived from and dependent upon the results produced by the engineer. It is, therefore, essential that the engineer should assert his leadership. He should maintain a reasonable amount of control over the situation and not have others do it for him.

### NEED FOR ENGINEERING STUDIES

From the foregoing, it will be seen that there is need for serious study by the engineer of remedies for the present conditions. The public is not interested in research itself but rather in the results of research. The engineer should therefore study to broaden his outlook to include not only engineering but also social utility and public welfare.

If the engineer believes, as does almost everyone, that the cost of government should be lowered and with it his taxes, he should study and analyze the problems confronting his government or community in order to contribute constructive criticism of governmental efforts. He should not continue to let others less able and often selfishly motivated make the decisions detrimental to him and at times not in the public interest. It is a human failing, particularly of engineers, to have a quite logical and economic solution of municipal problems but to permit, without tangible protest, less desirable solutions to be perpetrated upon the public. Engineers are essentially creators and builders and are therefore a powerful influence for good in the public interest.

A realization of this need for study and constructive effort is evidently appreciated by the American Society of Civil Engineers. That Society, through its Committee on Professional Objectives, presented at its annual meeting last January a Symposium on "Improvement of Social, Economic, and Professional Status of the Civil Engineering Profession." Some of the objectives of this committee are, (1) to concern itself actively with subjects incident to engineering practice, in order to develop and maintain high standards of practice and ethics, promote understanding among engineers and between the profession and the public; (2) to provide an agency through which both salaried and employer engineers may express themselves more freely and effectively on professional matters; (3) to give general consideration to national and state legislation affecting the engineer; (4) to give *particular* consideration to the economic and social status of the engineer and to national and social trends affecting him; and (5) to encourage and to demand a wider employment of engineers both in engineering and in technical works.

With the stated objectives of the American Society of Civil Engineers, the author believes the members of The American Society of Mechanical Engineers should be in hearty accord. In the final analysis, the ultimate goal of the engineering societies is the better development and greater advancement of its individual members. In striving to attain that goal, society and government will surely benefit.

### HOW CAN THE ENGINEER HELP?

But, you ask, what can the individual do about it? How can he help his city or community? How can he help himself? In answer, the following suggestions are proposed:

*Get Acquainted!* You have neighbors who are just like yourself and who have opinions to express. Learn their viewpoints; you will be surprised at how different they are. You will find that they, as in your own case, would much rather stay home and contain themselves in their own separate spheres of life and let the "other fellow" do the civic work. But, you should not complain if you yourself will not do anything to help.

Learn who are your representatives in local as well as in state offices. What is their background and experience? You may be amazed at their lack of previous experience in civic affairs.

What about your Board of Education? Who are they and what do they do? In many communities you will be surprised and pleased to find excellent members. This will inspire confidence and induce your support. In other communities you may be disappointed and see a need for change.

*Educate Yourself!* Inform yourself as to the problems under consideration by your local boards and representatives. Perhaps minor matters receive too much consideration and major items are neglected. The first step in considering any problem, as you know from your engineering work, is to obtain complete data before expressing an opinion.

What has your city or community done about planning, or housing, or safety, or law enforcement? Who are the individuals who concern themselves with these matters?

Civic associations and taxpayers' leagues are generally to be found in communities and cities of any size. Where they are not politically dominated and are able to maintain a nonpartisan attitude, they serve a useful purpose. While the author does not advocate joining a civic association or reform group, to do so is often broadening as well as informative.

*What Can You Do?* Assuming that you are now informed in a general way upon civic questions and the interested parties, the next step is to analyze your impressions. Questions of public interest, particularly appropriations and public works, are generally subject to the greatest discussion. Place yourself in the position of the local officials and list the arguments for and against. Attend a meeting of the local board and ask questions. Try out your comments on a neighbor. His reaction may not be as logical nor coincide with your views.

Sound out a local official for his reaction. To do so will show two things to him: First, that you are interested, and second, that you are thinking. You will also find that you can probably get from other sources further information which it may be well to secure. If you feel that you can make a suggestion or recommendation, do so by all means. The right kinds of public officials welcome suggestions and, even when busy, make every effort to answer all suggestions, inquiries, and recommendations. By so doing, the public official gets another viewpoint and may either modify his own idea or be confirmed in his convictions when answering you. The successful public official develops tact, patience, and tolerance and, in your dealings with him and others, you may acquire your share of such characteristics.

To many, the work of planning boards and similar commis-

sions is the most interesting activity of public bodies. It is deserving of this interest because of the importance of the questions generally handled. It may be possible for some of you to serve on such boards. Too often the smaller planning boards are composed of real-estate brokers and builders with never a flavoring of engineers. This is in large part due to the greater interest of the former and to the lack of interest of the engineers.

Particularly to the younger engineers, the suggestion is made to get out and get acquainted. It is realized that to do so for most men, and particularly engineers, is most unwelcome, because it is much more restful to the nerves and disposition to stay at home or go to the movies, and not take an active part in civic affairs. Aside from its educational value and as the duty of a free citizen in a troubled age, such activity lends support to the efforts of local leaders and definitely influences the trend for better government. Effective public understanding cannot be realized by a mere handful of broadly educated men; there must be not only those who serve the general welfare directly in their stated capacities but untold others who, as citizens possessed of higher education, will give critical thought and support to measures initiated for the public good.

#### BENEFITS TO BE DERIVED

The help rendered by the engineer to his city or community by civic activity is also of benefit to himself. Quite apart from the training such experience gives, it is of value, especially to the young engineer, in that it increases his acquaintance and broadens his outlook.

To the younger men of ability, progress seems very slow, with all the good jobs evidently being filled. It is interesting to reflect that those in good jobs are growing older at the same rate as those in minor jobs; in fact in this day and age, they are actually growing older faster. The younger engineers particularly should pay attention to their own preparation for these bigger jobs. They should keep their minds free from bias and broad in outlook because it is inevitable that some of them will have to perform the functions which are now performed by the older men.

To the engineer who is employed, experience in civic affairs gives the engineer a better appreciation of the relationship between his city or community and his employers, particularly if he is employed by one of the larger corporations. His value to his employers is greater, whether they know of his experience or not, because his viewpoint will be reflected eventually in the public relations of his employers, even though not remotely connected with the political subdivision in which he has become interested. The author does not believe it to be in the public interest for employees to be politically active in localities where they are engaged in business. They should, however, take an active part where such conditions do not prevail.

To the engineer who is not definitely established in some line of employment or in some company, such experience is often very helpful in leading to employment at times when it is most needed, due to the friendships which are made. Neither does this necessarily mean political friendships. Men of initiative and ability are sought even more by hardheaded business executives than by political leaders.

Another benefit to the engineer is often the public recognition which such activity affords. The engineer is on the threshold of increasing prominence. In the advertising over the radio and in publications, the engineer is mentioned many times as the authority for facts and new discoveries. It is, therefore, logical for the public to appreciate and to credit the engineer with efforts made toward civic betterment, and, as a result, to support him in his efforts along such lines.

Finally, to quote Dr. Robert E. Doherty, president of Carnegie Institute of Technology, who expresses a thought which seems particularly appropriate at this time:

"There are certain things to which we must cling at all costs. We must keep intellectual freedom; we must keep personal liberty to the greatest possible degree; we must keep incentives to constructive effort. These tongue-worn phrases still symbolize the American dream. They represent ideals for which great sacrifices already have been made in life, treasure, and change of view. And it is unthinkable that, as trustees of these gifts, we should fail in the decision and action that should preserve them.

"Will professional men not only in industry but also in politics, finance, and education, on all of whose shoulders this responsibility rests, act in time? Or will the ossification of view as we reach the age of professional decision prevent our taking the initial step that is necessary before the younger generation, yet in college, can have the opportunity to prepare itself? I have no fear, that, given plenty of time, we should not reach the right decision; I do have fear that under the now greatly increased tempo of life we may wait too long."

Bearing in mind what may not have been too clearly expressed by the author, will you not seriously consider the many and varied ways in which you, as engineers, can help your city and yourself? And if you can lend your aid in a field of endeavor which you feel will benefit your community, it is certain that you as well as your city or community will benefit.

## The National Labor Relations Act

(*Continued from page 741*)

Even more controversial is the general question of the requirement that the court accept the findings of fact if supported by evidence. The very statement is confusing. To what extent is the court to review the evidence to see whether it supports the findings of fact? Mr. Brook says: "The answer in common practice is that this phraseology throws the burden of proof upon the courts to show that the board's evidence does not support its findings. Only in extraordinary cases may a court find that the evidence does not support the findings. Under all ordinary circumstances the court must accept the findings of an administrative agency as established by the evidence in the record of the case."

Mr. Brooks then points out and discusses two reasons for this principle. One reason is to restrict the introduction of new evidence during the trial by the court, and the other reason is that such a procedure compels the court "to give way to the specialized training of administrative agents in questions of fact."

The various other issues involved in the relation of the courts to the board show, as have the foregoing brief examples, that there are sound reasons for the board's procedure being what it is, and also that the criticisms of this procedure, whether in general or in detail, are not substantiated by fact or judicial precedent. In general, it seems quite clear that the procedure, taken by itself, does not work a hardship upon the employer.

One cannot help obtaining a deeper understanding of the National Labor Relations Act by reading "Unions of Their Own Choosing." All of the broader issues are discussed, and each one is discussed in sufficient detail to give real substance to the arguments advanced. Nevertheless, one may conclude that it is a biased book. The act is biased, the board is biased, and the book is biased. In other words, the author is sympathetic with the aims and principles of the act. He "takes sides," if you will, but he brings understanding to the subject he is discussing.

# THE A.S.M.E. TODAY

## *I—After Sixty Years the Society Pursues Its Original Major Objectives*

MEMBERS of The American Society of Mechanical Engineers are likely to be amazed when they review the objectives, organization, and program of the Society. One has only to glance through the forty-odd pages of Society-administration personnel and committee lists issued annually to all members to realize why this is so. Here are listed the officers and committees concerned with administration, the 16 practically autonomous professional divisions (technical societies within the parent body), the 70 local sections (focal points for widely scattered geographical groupings of members), each with its own officers and organization, the 120 student branches and their officers, the hundreds of technical and special committees, and the dozens of joint activities in which the Society is represented and which in greater or lesser measure it supports. While most members are familiar with a few of these groups within the Society and the work they are doing, not many have a comprehensive understanding of the Society as a whole.

In an attempt to give A.S.M.E. members a comprehensive view of their Society, a series of articles has been prepared to outline briefly the present Society organization and the activities in which it is engaged. This introductory article deals chiefly with the background and early development of the Society and the objectives it has pursued since 1880. Succeeding articles will cover the present organization, activities, and programs. It is hoped that by means of these articles members will come to know their Society better and that their interest in its objectives, its program, and the opportunities that lie before it will be stimulated.

### THE FOUNDERS WERE CONCERNED WITH OBJECTIVES

Sixty years ago, widespread developments in the rapid industrialization of the United States led Prof. John Edson Sweet, professor of practical mechanics at Cornell University, Prof. Robert Henry Thurston, professor of mechanical engineering at Stevens Institute of Technology, and Alexander Lyman Holley, who was instrumental in bringing to this country the Bessemer process of manufacturing steel, to call a meeting, on Feb. 16, 1880, at the offices of the *American Machinist* in New York, where plans were laid for the organization of The American Society of Mechanical Engineers. At this meeting Mr. Holley presented an address[1] in which he advanced reasons for the establishment of a society of mechanical engineers. He cited examples of the work which obviously lay in this field and outside that of the two then existing engineering societies, the civil and the mining engineering societies. Three major advantages would, in his opinion, derive from the new engineering society: (1) The "collection and diffusion of definite and much needed information, by means of papers and discussion;" (2) the "general personal acquaintance thus promoted . . . . . among engineers and the businessmen associated with them;" and (3) the "habit of writing and discussing technical papers . . . . . which engenders habits of thought at once rapid and accurate."

Organization of the new society was perfected at a second meeting held on April 7, 1880, at the Stevens Institute of Technology, Hoboken, N. J., at which Henry R. Worthington presided and Prof. Robert Henry Thurston was elected first president of The American Society of Mechanical Engineers.

At the first Annual Meeting, held in New York on Nov. 4 and 5, 1880, Professor Thurston delivered the President's inaugural address[2] in which he also discussed the objects of the Society. To the general objectives put forward by Mr. Holley he added others. He spoke definitely of publication of the papers read and discussed, thus to build up a needed literature, and of the "gleaning from the great mass of technical literature . . . . such papers, wherever published . . . . . and presenting them, either in full or by abstract, to its own members . . . . ." He envisioned a Society headquarters as "an attractive resort socially." He said that "the Society's province will lie no less in the field of social economy than in that which has reference only to the individual interests of the members." He hoped that it might aid in the work of the "new organization of the Geological Survey," that it might perform useful services in the field of legislation, "in the encouragement of the useful arts, in the intelligent direction of the education of the people, and in the enlightenment of our national legislators in regard to the needs, the wishes, and the legal moral rights of the industrial classes in our country." Finally, he said, "the organization and combined action of members of this Society will be able to secure the investigation of many important problems, such as are familiar to everyone in the profession as urgently pressing for solution."

### EARLY PAPERS SET A HIGH STANDARD

With these objectives before it, objectives to which the Society today still adheres, there was much work for the youthful organization of representative engineers to do. How broad was the list of subjects discussed, the published papers of the first meetings that are preserved in volume 1 of the A.S.M.E. Transactions testify. There were papers on metallurgical furnaces and the Bessemer plant, on various phases of thermodynamics and engine design, on friction and lubrication, on industrial standardization, on the metric system, and on machine tools and "mechanical correctness." Many of these subjects, it will be noted, are still under discussion, and others, such as standardization, have grown into major Society activities. Among the authors of these first papers appear such names as Alexander Lyman Holley, Coleman Sellers, Charles T. Porter, John Edson Sweet, Allan Stirling, C. J. H. Woodbury, J. C. Hoadley, A. R. Wolff, G. R. Stetson, and S. W. Robinson.

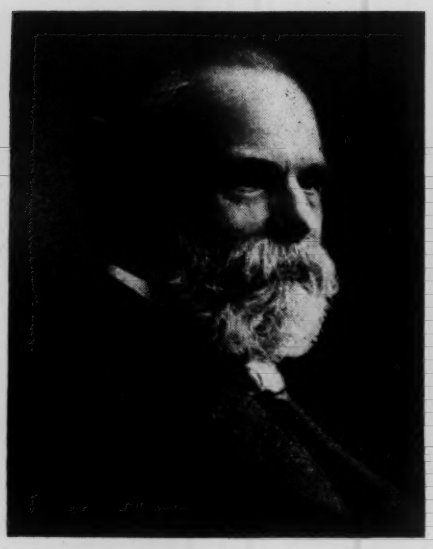
By the first Annual Meeting, Nov. 4–5, 1880, the membership numbered 189, the Council had met several times, funds in the bank amounted to $2563.93, and committees had been appointed. Vigor and enthusiasm were being exerted toward the attainment of the Society's objectives and the Society was well started on its historic career.

### PHASES OF DEVELOPMENT UNDER HUTTON AND RICE

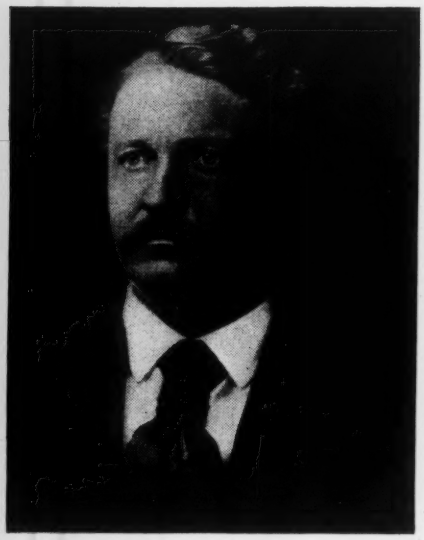
It is not the intention here to record the numerous steps in the growth and development of The American Society of Mechanical Engineers during the last sixty years. In 1883 Frederick Remsen Hutton, professor of mechanical engineering at Columbia University, became national secretary, a position which he held concurrently with his Columbia post until 1906, when he became president of the Society. Following his retire-

[1] "The Field of Mechanical Engineering," by Alexander Lyman Holley, Trans. A.S.M.E., vol. 1, 1880, pp. 7–12.

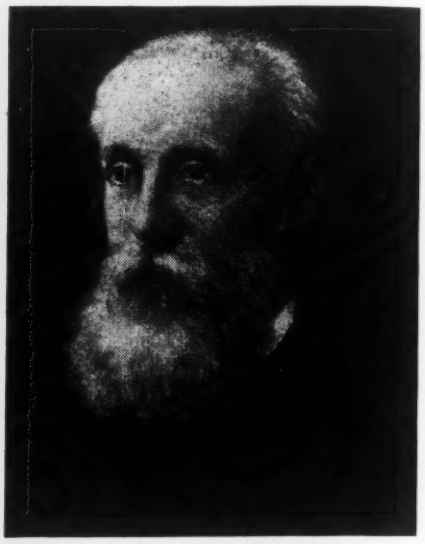
[2] "President's Inaugural Address," by R. H. Thurston, Trans. A.S.M.E., vol. 1, 1880, pp. 13–29.



ROBERT H. THURSTON



ALEXANDER LYMAN HOLLEY



HENRY R. WORTHINGTON

ment he undertook the preparation of a history of the Society[3] and in this informative and authoritative book the record of the first period of Society development may be found.

In 1930, in connection with the Society's jubilee celebration, a briefer historical review[4] covering important developments of the first 50 years was presented by Calvin W. Rice. Mr. Rice succeeded Professor Hutton and devoted his entire time and energy as national secretary of the Society from 1906 until his sudden death in 1934.

If a generalization on the characteristics of the two phases of Society history roughly covered by the secretaryships of Hutton and Rice may be permitted, it would be that during the first phase the Society devoted its principal efforts to its major task of developing and disseminating technical knowledge, while during the second phase it decentralized its organization, expanded its membership and the number and variety of its activities and interests, and exerted its influence in the advancement of industrial management and the application of engineering principles to the less technical problems of industry so brilliantly attacked by Frederick W. Taylor, and in cooperative relationship with other societies at home and abroad for the benefit of the engineering profession.

Marking the spirit as well as the beginning of this second phase was the construction, through the munificence of Andrew Carnegie, of the Engineering Societies Building in New York, headquarters of the four founder societies by whom, through the United Engineering Trustees, Inc., the property is now administered. The building itself was an outcome of a desire on the part of the societies to provide a common depository for their individual libraries, operated today as the Engineering Societies Library, also housed in the Engineering Societies Building, and jointly administered. From this successful endeavor in cooperation, many others have since followed, such as the Engineering Societies Employment Service, the Engineering Foundation, the Engineers' Council for Professional Development, the American Standards Association, and the American Engineering Council, whose headquarters are in Washington.

Although we may live too closely to the events themselves to judge wisely, the pattern of the third phase of the Society's development now in progress appears to be characterized by a growing concern for the engineer as a professional man, for engineering as one of the learned professions, and for the opportunities and obligations of public service, which involve economic and sociological as well as ethical, educational, and financial considerations. The present phase, which was initiated by a study of the 1930 earnings of mechanical engineers and which developed into a broader study of the economic status of the engineer, led to the formation of a comprehensive consideration of the engineer's development from his precollegiate days to his participation as a man of maturity in the practice of engineering, now directed by the Engineers' Council for Professional Development. The vital problems, personal, professional, and national, raised by the world-wide depression of the 1930's, have already influenced and given direction to this third phase. In terms of Society administration it is, like the two previous phases, roughly coincident with the secretaryship, held since the death of Calvin W. Rice in 1934, by C. E. Davies.

### REEXAMINATIONS OF SOCIETY OBJECTIVES

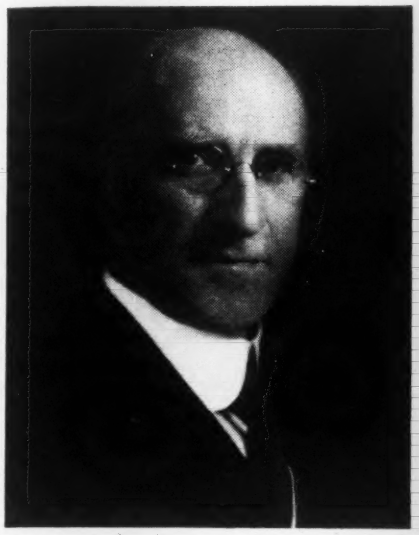
As each succeeding phase of development has taken shape, emphasis on the new and broader fields of interest has not retarded advancement of the major objectives of the phase that preceded it. Indeed, as the effects of the World War and later the influences of the depression of the 1930's were felt, a resurgence of the vital energies of the Society resulted in critical examinations, by specially appointed committees, of the objectives and activities of the Society. These examinations served to strengthen the determination of the Society to continue and even to enlarge its technical program, to ally itself even more closely with other engineering societies, and to broaden the field of its major interest and the diversity of its program.

For example: An important landmark in Society development, to which many of its present activities are referred was the report of a Committee on Aims and Organization in 1919.

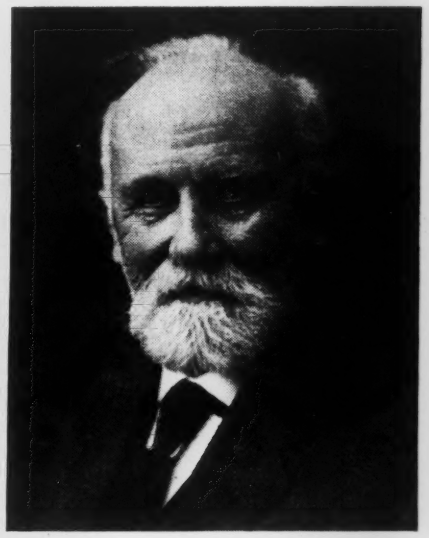
Out of this report grew the professional divisions and intensified programs of groups engaged in research and standardization; and emphasis was laid on the growth of student branches, on the need for encouraging education and training for the industries, on a revitalized Code of Ethics, on local-section activities, on publications, and on the employment service.

[3] "History of the Society," by Frederick Remsen Hutton, published by The American Society of Mechanical Engineers, New York, N. Y., 1915, 355 pp.

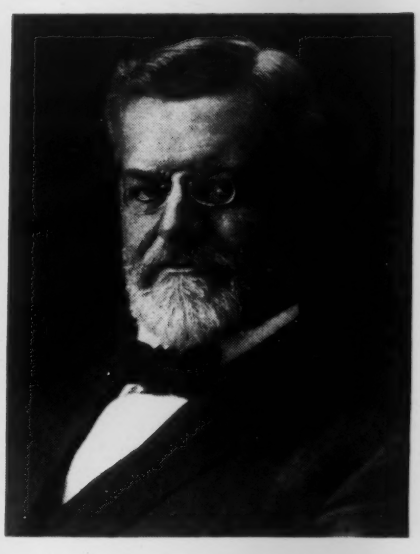
[4] "Fifty Years of the A.S.M.E.," by Calvin W. Rice, MECHANICAL ENGINEERING, April, 1930, pp. 261–276.



CALVIN W. RICE



JOHN EDSON SWEET



FREDERICK REMSEN HUTTON

A second landmark was the work of the Committee on Aims and Objectives, formed in 1932 as a result of the harassing conditions brought on by the world-wide depression of the 1930's. Financial problems were of greatest immediate concern to this committee, for income and membership losses threatened the Society's very existence. It was necessary to justify every expenditure of money and effort, to strengthen the Society's financial structure, and to effect every possible economy. These tasks were successfully carried out, and although at present the Society has a smaller membership and a smaller headquarters staff than it boasted ten years ago, essential services have not been given up, interests have broadened, new tasks have been undertaken, finances have been placed on a sound basis, and concern for the welfare and needs of the individual member, particularly those in the Junior and Student grades, is far greater than it was in the past. Ties with other engineering societies have been strengthened, and the program of assisting professional development and enhancing the economic status of the engineer is being carried forward by the Engineers' Council for Professional Development. At present, a Committee on Membership Development is initiating a national campaign to bring within the Society not only those who have recently been student members and are just beginning their professional careers, but men of mature attainments as well.

### MAJOR OBJECTIVES CHANGE BUT LITTLE

In 1937 The American Society of Mechanical Engineers materially revised its constitution, by-laws, and rules, and restated its objectives in the following form:

> The objects of this Society are to promote the art and science of mechanical engineering and the allied arts and sciences; to encourage original research; to foster engineering education; to advance the standards of engineering; to promote the intercourse of engineers among themselves and with allied technologists; and severally and in cooperation with other engineering and technical societies to broaden the usefulness of the engineering profession.
>
> The Society may approve or adopt any report, standard, code, formula, or recommended practice, but shall forbid and oppose the use of its name, emblem, or initials in any commercial work or business, except to indicate conformity with its standards or recommended practices. . . .
>
> The objectives of the Society shall be accomplished by:
>
> *A* Advancing the theory and practice of engineering and the allied arts and sciences by:
>
> (*a*) Encouraging engineering research, tests, and other original work.
>
> (*b*) Encouraging the preparation of original papers on engineering topics.
>
> (*c*) Holding meetings for the presentation and discussion of original papers and participating in international engineering congresses.
>
> (*d*) Publishing papers and reports and disseminating knowledge and experience of value to engineers.
>
> (*e*) Developing and promulgating standards, codes, formulas, and recommended practices.
>
> (*f*) Offering awards and other honors to encourage contributions to engineering; conferring awards and other honors in recognition of meritorious contributions to engineering.
>
> (*g*) Furthering the purposes of the Engineering Societies' Library, of which the Library of this Society forms a part.
>
> (*h*) Encouraging intercourse among engineers for the mutual exchange of knowledge and experience.
>
> *B* Enhancing the status of the engineer by:
>
> (*a*) Maintaining high technical and cultural standards for entrance to the Society.
>
> (*b*) Cooperating with educational institutions in the maintenance of high standards of engineering education.
>
> (*c*) Requiring a high standard of ethical practice by members of the Society.
>
> (*d*) Aiding in the adoption of a high standard of attainment for the granting of the legal right to practice professional engineering.
>
> (*e*) Fostering among engineering students the study of philosophy and history, tradition and achievements, duties, and social functions of the engineering profession.
>
> (*f*) Encouraging the personal and professional development of young engineers.
>
> (*g*) Supporting activities looking to the increased employment of engineers and seeking new opportunities for engineering service.
>
> *C* Increasing the usefulness of the organized engineering profession by:
>
> (*a*) Cooperating with other engineering and technical societies.
>
> (*b*) Encouraging a high standard of citizenship among engineers.
>
> (*c*) Encouraging engineers to participate in public affairs.
>
> (*d*) Cooperating with governmental agencies in engineering matters.
>
> (*e*) Publicity for the engineering profession through the achievements of engineers.

It will be noted that except for differences of wording and emphasis the objectives of The American Society of Mechanical Engineers as officially stated nearly sixty years after its formation are the same as those set up for it by Alexander Lyman Holley and Robert H. Thurston in 1880.

Of the means by which the objectives are being carried out today by the officers and committees of the Society, succeeding articles of this series will endeavor to make clear.

# BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

## Day by Day

THE long awaited conflict in Europe opened on September 3. Tension in Great Britain over the impending declaration of war was so great that the British American Engineering Congress, scheduled for New York Sept. 4–8, was canceled, resulting in the abandonment of all plans for the 1939 Fall Meeting of The American Society of Mechanical Engineers which was to have been held in connection with the Congress.

Another meeting in which the A.S.M.E. was planning to participate through its Machine Shop Practice Division was also canceled, the Machine Tool Congress, which had been scheduled in connection with the Machine Tool Exhibition for Oct. 4–13 at Cleveland, Ohio. Plans for the exhibition were also abandoned.

With events moving swiftly at home and abroad indications are that mechanical engineers will find plenty of work to do in the next few years.

It is gratifying to note that several members of The American Society of Mechanical Engineers are serving on a committee of businessmen, appointed by Assistant Secretary of War Louis Johnson, to review the educational-orders program of the War Department and to recommend such objectives and methods of administration as will render these orders of greatest value. Under the chairmanship of Brig.-Gen. Benedict Crowell, Director of Munitions during the late World War, are serving: E. M. Allen, president, Mathieson Alkali Works, New York City; Carl L. Bausch, manager A.S.M.E., vice-president, Bausch & Lomb Optical Co., Rochester, N. Y.; Frank B. Bell, member A.S.M.E., president, Edgewater Steel Co., Pittsburgh, Pa.; W. W. Coleman, member A.S.M.E., president, Bucyrus-Erie Company, South Milwaukee, Wis.; Donald W. Douglas, president, Douglas Aircraft Co., Santa Monica, Cal.; John M. Hancock, Lehman Bros., New York City; William S. Knudsen, president, General Motors Corp., Detroit, Mich.; J. L. Perry, president, Carnegie-Illinois Steel Corp., Pittsburgh, Pa.; Charles J. Stilwell, vice-president, Warner & Swasey Co., Cleveland, Ohio; and L. A. Codd, editor of *Army Ordnance*, Washington, D. C.

## *Engineer's Testimony*

Looking back on a long and useful career as a bridge engineer, Otis E. Hovey, member A.S.M.E., writes in the August issue of *Civil Engineering* of some of his experiences. His testimony on the qualifications of an engineer and satisfactions of his work applies broadly. He says:

> A successful engineer must possess and develop a high type of character. He must be meticulously honest with himself and with others. He must be obedient to the laws of nature so far as he can grasp them. He must be logical, thorough, industrious, inventive, practical, firm in well-grounded opinions, yet tolerant of the views of others and able to associate comfortably with them. At the same time, he must see visions and dream dreams, whether in structures, machines, organizations, business, or human relationships. Given the right temperament, abilities, and training, it is difficult to choose a more attractive profession. New problems challenge solution, and monotony is almost unknown. There is keen satisfaction in seeing visions realized. One's daily occupation reacts favorably on the development of character and personality, and he has a wonderful time as long as he is able to think and work.
>
> While the financial rewards may not be large, the inner satisfactions are great. The engineer feels that he has at least done a little to advance civilization and the enjoyment of life by his friends and the public in general. As a career and a culture, it seems to me that the engineering profession leads all others.

## *Parsons*

The fifty-year anniversary of C. A. Parsons & Co., Ltd., of Newcastle upon Tyne, England, provides occasion for that company's publication, *Heaton Works Journal*, in its summer issue, to take appropriate and, it may be said, affectionate notice of the great steam-turbine pioneer, Sir Charles Parsons, who was an honorary member of The American Society of Mechanical Engineers. Mr. Francis Hodgkinson, another honorary member of the Society, contributes his recollections of Sir Charles, as do many other former associates. The principal fascination in reading the lives of most engineers lies in the story of their technical achievements. With Parsons there is such a wealth of anecdote about the engagingly human quality of the man himself that the reader is doubly repaid for his pains. Parsons' versatility as an engineer is quite as fruitful a source of biographical material as his personality. The world knows of him principally as the builder of steam turbines, but apparently any kind of an engineering problem appealed to him. Sir Alfred Ewing wrote of him: "His development of the steam turbine is incomparably the greatest achievement of any living engineer, the greatest both in its effects and in the genius and courage it has required;" and Sir William Bragg has said: "Had Parsons not stuck to applied science, he would probably have become the world's greatest physicist."

## *N.A.C.A.*

In a modest but abundantly illustrated pamphlet of less than two dozen pages the National Advisory Committee for Aeronautics has recently provided a brief description of some of the committee's researches and of the equipment employed at its laboratories at Langley Field. Brief mention is made of the variable-density wind tunnel, N.A.C.A. airfoil section, early large-scale investigations, wing-nacelle investigations, N.A.C.A. cowling, the full-scale wind tunnel, the smoke tunnel, the 8-ft high-speed (500-mph) wind tunnel, high-speed researches (up to the speed of sound) in the 2-ft wind tunnel, investigations of high-lift devices and of stability and control in the 12-ft free-flight tunnel, aircraft-engine research in cooling, increase of engine power, and spray combustion, and research

on seaplane floats and hulls in the 2900-ft towing tank. In spite of its brevity, the pamphlet illustrates the extent and variety of the committee's researches.

## *Ferris Advanced by TVA*

The Tennessee Valley Authority announced on July 26 the appointment of John P. Ferris, member A.S.M.E. as director of the Authority's newly reorganized Commerce Department. It is said that the new department will be composed of the TVA's old Agricultural Industries Department, of which Mr. Ferris was formerly the head, and the Commerce Department, formerly headed by J. Haden Alldredge, recently appointed to the I.C.C. Mr. Ferris, who writes frequently for MECHANICAL ENGINEERING, spent 15 years with the Oilgear Co., Milwaukee, Wis., as assistant chief engineer and later as chief engineer before he entered the public service with the TVA.

## *Land Speed Record*

At Bonneville Salt Flats, Utah, on August 23, John Cobb, British businessman, established a new automobile speed record by driving his 2600-hp Railton "Red Lion" at 368.85 mph over the measured-mile course. He thus broke the previous record of 357.5 mph set on the Bonneville course by another Englishman, Capt. George E. T. Eyston. On his outrun Mr. Cobb's speed was 370.75; on the return run it was 366.97.

# High-Explosive Bombs

ARMY ORDNANCE

SCIENTISTS in England have made tests which indicate that there would be 17 casualties per ton of high-explosive bombs dumped on London even though all inhabitants were protected by air-raid shelters. The reason for this, according to an article in *Army Ordnance*, September-October, 1939, written by Tenney L. Davis, of M.I.T., is the "blast" effect of the high explosive itself, an effect so sudden that it neither needs nor tolerates confinement. Things go away from the place where a high explosive detonates. The space itself conducts electricity; the air is ionized; and the electrons have been shaken out of the atoms. The effect is fearfully shocking.

What are high-explosive bombs made of? Professor Davis says that for ordinary shells and bombs, trinitrotoluene (TNT) is probably the most satisfactory explosive there is. It will tolerate all ordinary shocks and will not explode from the impact of a high-powered rifle bullet. Yet it is detonated easily and surely by a fulminate detonator, a booster of compressed granular TNT being used to insure the better detonation of the main charge of TNT, which usually is cast. TNT is easy to purify to uniformly high quality, chemically inert, easily loaded, powerful in action, and does not attack the metal parts of ammunition. A high-explosive bomb serves its purpose against personnel if the fragments into which it is blown are not too small. TNT produces fragments which are of quarter-inch size or larger. A shell loaded with trinitrobenzene (TNB) is more powerful than one loaded with TNT, but TNB produces smaller shell fragments.

Liquid-oxygen explosives have many advantages, but they are unsuitable, even impossible, for use in bombs. If an absorbent mass of combustible material, such as a cylindrical carton filled with wood pulp, cork dust, or powdered aluminum, is dipped into liquid air or liquid oxygen, it takes up the liquid and the resulting cylinder is to all intents and purposes a stick of dynamite. It is a sensitive and powerful explosive, one which is cheap and easy to prepare, but it will not keep because the liquid oxygen evaporates away and the shell loses its power to explode. Almost any liquid which is a concentrated oxidizing agent will act in the same way as liquid oxygen. Fuming nitric acid is such a material, but it attacks metal and reacts promptly and at ordinary temperature with many combustible substances, without heat or any initial shock to start the reaction, producing heat, fumes, and often a fire or an explosion. If nitrobenzene is dissolved in fuming nitric acid, there is no immediate reaction, and the resulting liquid is a powerful, sensitive, and reasonably stable high explosive. Nitrogen dioxide is an oxidizing gas which is liquefied easily and which may conveniently and safely be kept in closed containers. Mixed with carbon disulphide or gasoline, it forms an explosive called anilite.

Nitroguanidine is made by chemical treatment of the fixed nitrogen resulting from the cyanamide process. It is a cool and flashless explosive about as powerful, weight for weight, as TNT. During the World War, the Germans used Minenwerfer bombs loaded with a mixture of ammonium nitrate, nitroguanidine, and paraffin wax, a fairly insensitive composition which is suitable for use in drop bombs. These explode

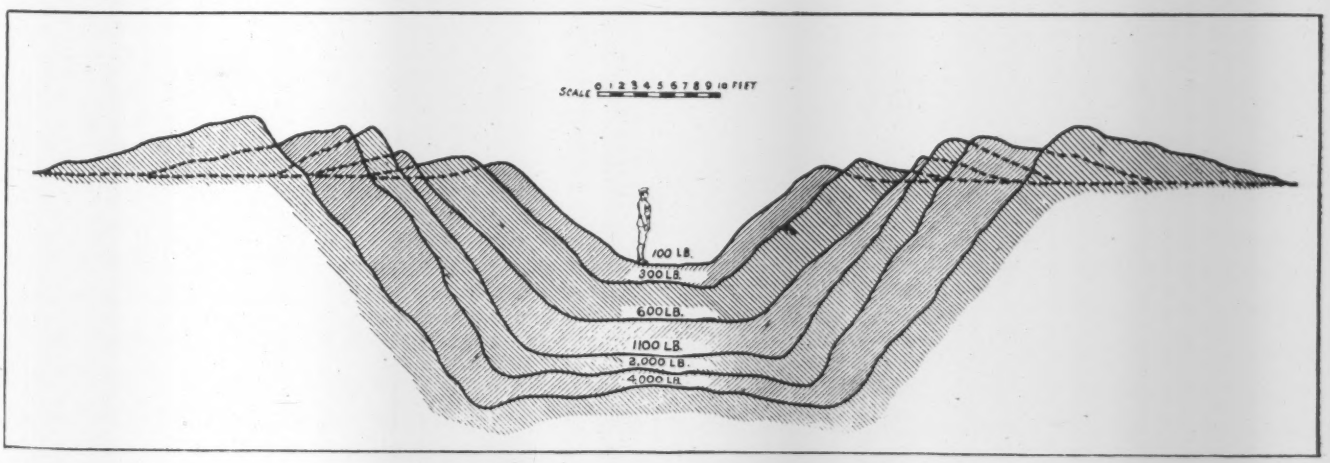



FIG. 1 CRATERS OF DEMOLITION BOMBS

(The diagram indicates craters produced by demolition bombs varying in weight from 100 to 4000 lb, using delay fuses in ordinary ground. The crater of the 4000-lb bomb is 57 ft in diameter and 19 ft in depth, with respect to the original ground level. This bomb displaced 1078 cu yd of earth.)

in the first instance because of the nitroguanidine and this brings the ammonium nitrate into play, which explodes and reacts, or reacts and explodes, with the combustible paraffin.

Amatols are prepared by mixing granular ammonium nitrate with melted TNT, and then loading the warm plastic mass into bombs. Each particle of the hygroscopic ammonium nitrate is thus covered with a layer of TNT and protected from moisture. Another typical explosive is the ammonal type, which consists of TNT, ammonium nitrate, and aluminum powder. The affinity of aluminum for oxygen is great; it burns with the production of much heat and of dazzling light. The explosion of ammonal makes a brilliant flash, and its action is more brisant (shattering) than that of similar explosives which contain other combustibles.

Dynamite and other explosives containing nitroglycerine are much too sensitive to be used for bombardment purposes. Bombs for the destruction of buildings and other property must not explode when they hit their target but first must penetrate into it. Landing on the roof of a building, the bombs should reach the basement before exploding. Finally, all airplane bombs must be so insensitive that they will not explode if they are struck by an enemy bullet or shell fragment while the airplane is carrying them. These factors and ever-present considerations of cost and availability, determine and limit the choice of high explosives for use in bombs.

# Opposed-Piston Diesel Engine

ENGINEERING

A NEW Diesel engine of the opposed-piston type and embodying a simple method of coupling the pistons to the crankshaft has been developed in Switzerland. As described in an article appearing in the July 28, 1939, issue of *Engineering*, the engine is operated on the two-stroke cycle and manufactured with two, three, and four cylinders, developing, respectively, 40, 60, and 80 bhp at 1000 rpm. This speed is used for heavy duty when the engine runs continuously for long periods at full load. For average industrial work, the designed speed is 1250 rpm, with outputs of 50, 75, and 100 bhp. For peak-load and stand-by plants, rail vehicles, motor launches, and other services where the maximum speed and output is required only for short periods, a speed of 1500 rpm develops 60, 90, and 120 bhp, respectively.

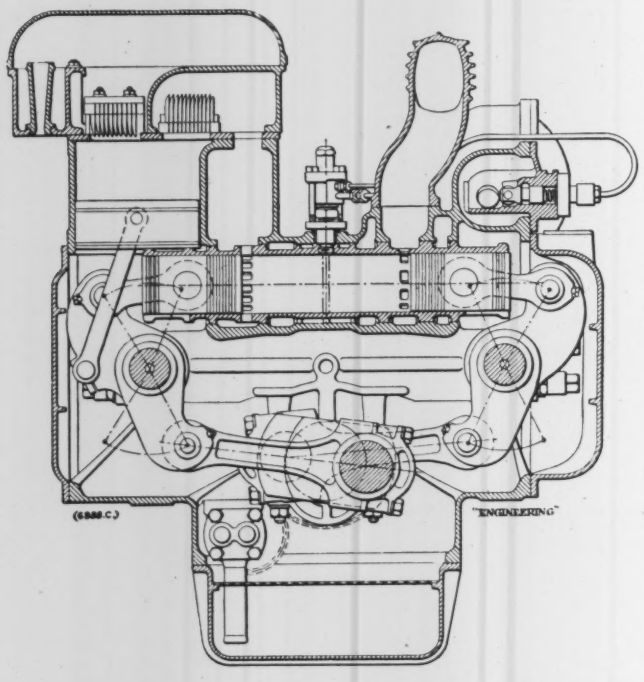



FIG. 2 TWO-STROKE OPPOSED-PISTON DIESEL ENGINE

As shown in Fig. 2, the cylinders of the engine are horizontal. The crankshaft is below the cylinders, there being two throws set at 180 deg for each cylinder. There are, of course, no cylinder covers, as combustion takes place in the cylinder between the two pistons, and the motion is conveyed from each piston to the corresponding crankpin by an upper and lower connecting rod coupled to the two ends of a rocking lever. The cylinder liners, of special cast iron, are finished by honing on the working surfaces, and are replaceable and interchangeable. They are fixed in place without the use of rubber water joints. The pistons are of the two-part type, the crowns being of special heat-resisting material. To facilitate their removal, each rocking lever is mounted on a short shaft held at each end in split bearings, and when the two bearing caps are removed, the pin at the small end of the lower connecting rod can be taken out, and the piston, upper connecting rod, and rocking lever withdrawn as one unit.

The fuel pumps, one of which is shown to the right in Fig. 2, above the cylinder, are operated by a camshaft in an enclosed casing, the camshaft being driven from the crankshaft through spur gearing. Each pump delivers its oil at a suitable pressure to an injector which is mounted above the cylinder at its center. A self-contained scavenger pump is fitted to each cylinder and is driven by a rod from one of the rocking levers, as shown to the left in Fig. 2. The arrangement of the pump valves, and of the inlet ports, is also shown.

The engine will operate satisfactorily on any of the usual Diesel fuels with a specific gravity between 0.85 and 0.88, the consumption at full load amounting to about 0.4 lb per bhp. It may be pointed out in conclusion that the opposed-piston arrangement results in an exceptionally good balance and very little vibration.

# Boiler and Machinery Insurance

AMERICAN MANAGEMENT ASSOCIATION

BOILER and machinery insurance is primarily a loss-preventive service, and only secondarily a loss-payment service, according to Reginald Fleming and James H. Coburn in talks presented at the Insurance Conference of the American Management Association, held at Atlantic City, N. J., May 22–23, 1939. This insurance functions as does the time-honored and logical Chinese doctor—the insurance company is paid to prevent the insured from suffering a loss.

Over a period of 75 years, inspection of boilers to prevent explosion has so progressed that, at present, although there is still more progress to be made because of recent changes in boiler design, a catastrophe is a rare occurrence. And, asserted Mr. Coburn, most, if not all, boiler catastrophes today can be laid at the door of the insuring company, either because it did not discover the obvious defects which would naturally lead to disaster, or detecting them, did not insist upon immediate correction of such defects under penalty of suspension of the insurance.

Mr. Fleming contended that the insurance companies have not convinced the insuring public that the services of the machinery inspector are as valuable as those of the boiler inspector. In answering for the insurance companies, Mr. Coburn showed that machinery-breakdown insurance is hardly

20 years old. It takes time for the insuring public to realize the benefits derived from inspection of machinery. While the loss frequency of Mr. Coburn's company at first was about one in 10 insured machines annually, it has declined each year until it is now about one in 27. Surely this of itself is an indication of the value of inspection. This independent inspection of machinery of all types, engines, turbines, and others has definitely prevented losses and brought to the policyholder specific recommendations which have enabled him to enhance the life of his machines and to promote efficiency.

# Researches in Steel Metallurgy

NATURE (GREAT BRITAIN)

RESEARCH in steel metallurgy, according to an article by Dr. W. H. Hatfield, British metallurgist, in *Nature* for July 8, 1939, is directed in the main to three principal aspects: (*a*) Elucidation and improvement of the processes of steel manufacture and manipulation; (*b*) investigation of the properties of steel under variable conditions approximating those of service; and (*c*) exploration of the influence of added elements and of the effect of heat-treatment in advantageously modifying the properties of steel and producing those best required under (*b*). It can in truth be said that great progress has taken place under each heading of late years. However, further research is necessary to answer the future needs of engineers. This new work is described by Dr. Hatfield in his article.

For instance, as a result of the reactions of the steelmaking process, the liquid steel contains, disseminated through it, small quantities of oxides of silicon, iron, manganese, and other elements, but during the cooling and freezing process these oxides coalesce and orient themselves in well-defined design; along with these oxides are sulphides resulting from the sulphur content of the steel. Such oxides and sulphides weaken the metal transversely to the direction of forging and rolling. Consequently, any mitigation of the trouble by reduction of the oxide and sulphide content is much to be encouraged.

This problem is steadily yielding to study and experiment, although the experimental difficulties are great. The compounds in equilibrium or indeed in existence at 2900 F in the liquid phases are not necessarily those encountered at 60 F. Solubilities are different, and hence, for example, the difficulties of studying the solubility of gases. It is important to know the oxygen content and its condition in the liquid steel; one great step forward has been the development of the vacuum-fusion method of determining the total oxygen in the final steel, but the research scientists have not as yet mastered the technique of determining the form in which the oxygen occurs. The nitrogen and hydrogen contents of steel are also having much attention, and these, particularly the hydrogen content, may prove of consequence.

Perhaps one of the most complex studies is that of the changing properties of steel with varying temperatures. It is of the utmost importance to the engineer that he should know the stresses the material will withstand under such changing and different conditions. Important steam-raising and power-generating units operate at temperatures up to 950 F, while items such as exhaust valves, superheater, and furnace parts operate at 1300 F to more than 2000 F. On the other hand steels used in airplane construction and special engineering must encounter very low temperatures; indeed, for experimental work, steel has been supplied to operate at —300 F. This study includes a knowledge of the properties of steel at ordinary temperature and at the special temperatures after a lapse of time comparable with the later stages in the length of life of the part under service conditions. Among the subjects being studied are the phenomenon of creep, oxidation at high temperatures, and the effect of exposure to temperature for a long time upon the mechanical properties of various steels.

The multiplicity of alloys which it would be necessary to make to explore thoroughly the possibilities of the influence of added elements is obvious, and, therefore, it is clear that only the fringe of the subject has yet been explored. High-tensile steels are available through the influence of small quantities of added elements, but the more outstanding advances relate to the influence of large additions of the special elements. A high percentage of nickel produces a steel with a very low coefficient of expansion, while certain percentages of nickel, manganese, and chromium enable steel to be produced with a high coefficient of expansion comparable with that of the aluminum alloys. High percentage of cobalt or of nickel and aluminum enable magnets of amazingly high coercive force to be produced. The presence of small quantities of chromium and aluminum enable hardened surfaces to be produced by the influence of ammonia at temperatures as low as 900–1000 F.

High manganese content produces a steel of excellent wearing properties under abrasion, while high chromium or high chromium and nickel contents produce a range of steels which are rust- and acid-resisting. Add to the last category other special elements and the interesting heat-resisting steels are produced which not only resist scaling at high temperatures, but have also considerable strength under such conditions.

One is invariably asked, "Why are the rustless steels rustless?" The answer is, that they are cases of passivity, induced by composition and normal environment in the production of a passive external film. This is in part proved by the fact that under certain conditions local corrosion will take place even with so-defined rustless steels, as a result of shielding action. Shielding action is the effect of a deposit of material resting on the surface of the steel, which by its presence partially or completely prevents free access of oxygen to this surface of the steel, and thereby retards or prevents the repair of any minor breakdown of passivity. Evidence indicates that the corrosion-resisting properties of the rustless steels are due to the chromium facilitating the spontaneous production of a protecting film of the necessary characteristics for resistance, which film if damaged is spontaneously renewed.

Experimenting upon the basis of the rustless-steel compositions, it has been found that by modifying the chromium and nickel and also by adding other elements such as tungsten, molybdenum, cobalt, or titanium, steels are produced which maintain a reasonably protective film at temperatures even in excess of 1800 F and also have useful strength.

# Metal Spinning

THE IRON AGE

METAL spinning is a technique of forming metal at low cost and with superior finished characteristics. Up to a few years ago, spinning was confined wholly to nonferrous metals, such as aluminum, copper, pewter, zinc, and brass, and the shapes formed were limited to simple designs. However, the art has advanced to such a degree that today really complex spinnings in practically all metals, including stainless steel, are being used in aircraft, automobiles, machines, and tools, by ornamental-metal works, and by a long list of manufacturers of food-processing equipment and builders of capital-goods equipment. The following abstract is taken from an article, giving the why, the what, and the how of the process,

by T. J. Salow, Jr., appearing in *The Iron Age* for Aug. 24, 1939.

A simple spinning may be turned out by a skilled craftsman in a few minutes. The machine used is a lathe, somewhat similar to a woodturning lathe but faster and more powerful. The first operation is to turn a wood or metal block to the exact size and shape of the object to be produced. Such a block serves the same purpose in spinning that a die does in stamping. The block can be used to make thousands of spinnings, and the original cost is small compared to the cost of a die.

The block is screwed to the spindle of the spinning lathe. A round, flat metal blank is clamped against the block. The lathe is then started, causing both the block and the blank to revolve, or spin, at a high rate of speed. The spinner selects a tool, usually a long, blunt steel rod, the blunt end of which he presses against the whirling blank. By expertly working the tool back and forth from the center to the outer edge of the blank, he finally lays the metal down so that it fits over the block like a glove. The spinning is taken off the block, another blank is clamped on, and the spinner starts again. Simple articles require but one operation; an intricate article, however, may take several operations and annealing before it is finally spun to the correct shape.

Perhaps the most important single factor in spinning is the individual skill of the operator in using the correct pressure to form desired shapes, in obtaining correct thicknesses of metals, and in avoiding workhardening. As skill is dependent on individualism, so also are the forms of the tools used and the technique followed in applying them. The operators of modern spinning lathes use many of the common tools, but in the last few years a great expansion in types of work handled has required the development of a wholly new kit of gadgets, particularly those for working ferrous metals. These tools have been custom-designed to bring about certain desired results and reactions in metal and are "stock in trade" that are very closely guarded.

Just how fast and how far spinning stainless steel has progressed may be judged by the fact that only 12 months ago the spinning of a flanged and dished head was regarded with open-mouthed wonder. Today, it is not out of the ordinary to form a 42-in-diameter ball out of 14-gage steel. As spinning advanced into the field of ferrous metals and alloys, it was matched by corresponding progress in handling sheer physical size. A spinning 36 in. in diameter was considered a phenomenon a few years ago. Today spinnings as large as 90 in. in diameter are regularly being formed. Examples of the products of spinning include stainless-steel mandrels for the production of paper cups, stainless-steel engine cowls for aircraft, a Diesel-engine injector sleeve of copper, and a miniature scale model of a steel beer barrel for use by salesmen in selling the full-sized product.

# Flax in the Cotton Industry

A.S.M.E. TEXTILE DIVISION MEETING, GREENVILLE, S. C.

FLAX has been investigated as to its adaptability to Southern agriculture and the utilization of its fibers in the cotton-textile industry by scientists of the Engineering Experiment Station of the Georgia School of Technology and the Tennessee Valley Authority. A report of the progress made since the research program was started three years ago was given by C. G. Worthington, member A.S.M.E., and research fellow, Georgia School of Technology, at the meeting of the Textile Division of The American Society of Mechanical Engineers in Greenville, S. C., April 5, 1939. Excerpts from the paper follow. A paper in which Mr. Worthington covers the same subject will be found in the *American Dyestuff Reporter* for Feb. 6, 1939.

The subject of the investigation reported by Mr. Worthington is the solution of a twofold problem: (1) Extraction and preparation of the fiber from flax straw at low cost, and (2) utilization of this fiber on cotton machinery. A processing method that, in a sense, is a reversal of the established European procedure has been followed. "Green" fiber is first extracted from the straw by mechanical scutching or decortication, and then subjected to chemical retting or degumming to prepare it for spinning. This method was adopted in the belief that it might offer a cheaper and more satisfactory way of processing than the European procedure of water retting followed by scutching, which is expensive, laborious, and disagreeable. Approximately ten tons of fiber flax and seed flax grown in Georgia and Oregon during the last two years have been processed to date.

The purpose of decortication is to separate the principal elements of the flax plant from each other, that is, seed, fiber, and woody core or shive. As the amount of green fiber in a flax plant represents only 15 to 20 per cent of its over-all weight and the seed about the same, a machine must deseed and decorticate straw at low labor and power costs. At the same time, it must produce a fiber clean of shive, the woody core material that makes up about 50 per cent of the weight of the flax plant and is, at present, a waste material. Two experimental machines that have been on trial at the Engineering Experiment Station during the last year seem to meet the foregoing requirements and are suited to small-scale commercial operation. The straw first passes through a number of coarse, fluted rolls which remove the seed bolls and give the straw a preliminary breaking that loosens the fibers from the woody core. It then goes through a series of reciprocating, slotted knives that impart a rubbing action which cleans out the shive, and the fibers are discharged in hanks of long fibrous ribbons. These machines require only two operators and little power, and could be set up in a small plant, like a cotton gin, near the flax fields. This is important from the standpoint of production costs because the bulk of the flax plant is shive, primarily a waste material and uneconomical to transport.

The straw must be well dried before decortication in order to obtain clean fiber. Best results seem to be obtained when the moisture content of the straw is in the range of from three to five per cent. Flax is very hygroscopic and artificial means of drying would have to be provided in most regions in connection with the decortication equipment. Experience at the station indicates that the straw could be economically handled and conditioned in a large storage space with simple equipment to heat and circulate air at the moderate temperatures and low humidities required.

The problem in degumming is to remove the shive still clinging to the decorticated fibrous ribbons or bundles of fiber, and enough of the gum to allow separation of these bundles into nearly the ultimate fibers of flax, so that they can be handled on cotton machinery. The method of treatment adopted involves an alkaline hydrolysis with a mild reducing action to prevent oxidation of the cellulose fibers. It is carried on in a pressure vessel, with outside means of heating and circulation of the liquid at a temperature of about 330 F for one to one and one-half hours. The product comes in matted hanks of finely divided and long fibers which are then washed, dried, and prepared for spinning. Degumming reduces the weight of the decorticated fibers about 50 per cent.

Present procedure of preparation requires some mechanical pretreatment and conditioning. The matted hanks are cut into the required staple lengths and then passed through a waste-opening machine and a picker where they are opened up. This

action tends to break the fibers so that a staple of variable length is produced. Subsequent processing in the card results in considerable waste loss when running 100 per cent flax and some difficulties in forming a web and sliver. This produces yarns which lack the uniformity and strength that is desired.

Cotton machinery is built to handle a fine and soft fiber that is fairly uniform in length and diameter. Degummed or "cottonized" flax fiber does not have the softness or uniformity of cotton, nor does it have cotton's characteristic spirality which gives the latter such good spinning qualities. Flax fiber is straight, smooth, and comparatively stiff. However, experiments indicate that improved degummed fibers are possible and, with certain modifications in cotton machinery, may be used to produce 100 per cent flax yarns of average counts. Of more immediate interest, perhaps, is the fact that mixtures of cotton or rayon with degummed flax considerably improves the latter's spinnability and the uniformity, strength, and fineness of the yarns produced. This is important because of the present trend toward mixed or blended fiber fabrics for certain classes of goods, such as cotton-flax toweling, draperies, tablecloths, and summer suitings.

# Diamond Hardness Tester

NATIONAL BUREAU OF STANDARDS

THE PERFORMANCE of seven indenting tools of different angular formation was investigated by Frederick Knoop, C. G. Peters, and W. B. Emerson, of the National Bureau of Standards, to determine their relative sensitivity and adaptability in "hardness" tests of different materials and to determine also the effect of load and of different dimensional bases of computation on the indentation number. As reported by the experimenters in the July, 1939, *Journal of Research*, published by the Bureau, consideration of the results led to the selection of a sensitive pyramidal-diamond indenting tool which gives excellent performance in many materials. It was found that the tool gives indentations of accurately measurable length, with loads of less than one kilogram, in the most resistant steels, in small specimens, and in brittle materials, such as glasses, dental plastics, enamels, and porcelains.

The indenting tool consists of a diamond crystal of 0.25 to 1.5 carats rigidly mounted in a metal holder for cutting and use. Fig. 3 shows, schematically, the shape of the tool together with its resulting indentation. The sensitivity of this indenter results from its elongated shape, which, for this tool, gives an indentation of length *l*, which is about seven times the width *w*, and 30 times the depth *d*. From consideration of displacement, it is evident that a specimen under load will be greatly strained at *BB* and relatively unstrained beyond *AA*.

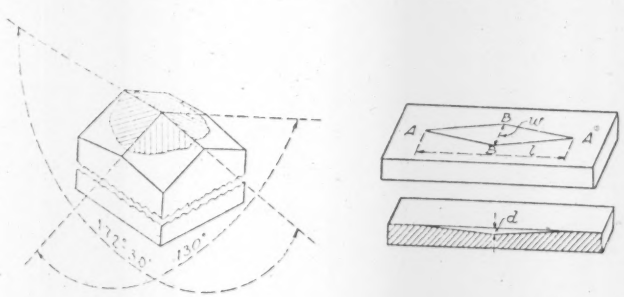



FIG. 3. A SENSITIVE PYRAMIDAL-DIAMOND TOOL FOR INDENTATION MEASUREMENTS

This is substantiated by examination of indentations in transparent materials in polarized light and also by the appearance of indentations in brittle materials under excessive loads which shows decreasing rupture of the specimens from a maximum at *B* to none at *A*. These considerations indicate that the major part of the elastic recovery of an indentation upon removal of the indenter will take place crosswise rather than lengthwise of the indentation. Further, although only the modulus of cubic compressibility of the diamond has been measured, its high value ($5.5 \times 10^{12}$ dynes per sq cm) makes it certain that the relative deformation of a diamond indenter will be small in comparison with the deformation of the indented material. Consequently, from the measurement of a single dimension, *l*, and from the indenter constants in terms of *l*, a close approximation to the unrecovered width, lateral or contact area, projected area, penetration, and volume becomes known; and with an added measurement of the width *w* of the final indentation, the recovered projected area may likewise be determined.

The cut diamonds have plane faces which intersect in edges that appear straight and free from the most minute nicks when viewed under a magnification of 75. The angles of these diamonds can be readily measured to the required accuracy, and indenters can be duplicated with an exactness sufficient to give the same results on a given material within the range of experimental error. Cut diamonds seem to show little wear when used for indenting purposes; in fact, no wear was discernible in the indenters used in the present work after two years' service.

In considering the performance of the diamond-based pyramid indenter, the chief characteristic which warrants its introduction among other indenters is its sensitivity. Although its use is not restricted to small loads, loads of 0.5 kg are sufficient to give indentation lengths of 100 $\mu$ in the hardest steel tested; and, with indentations of this length, differences in indentation numbers greater than two per cent in well-surfaced specimens may be attributed to nonuniformity of the specimen. The use of light loads permits the satisfactory testing of many brittle materials which could not be tested satisfactorily by other indentation methods, and the resulting indentation numbers for these materials fall within the range of present indentation scales for metals. Although no extensive study has yet been made of minimum thicknesses which may be tested, useful information was obtained from tests of layers 0.0005 in. thick.

# Okoumé Wood

THE WOOD-WORKER

OKOUMÉ WOOD, an African timber, first brought to European attention in 1885, is now said to be the most important species exported from Africa to Europe, according to an article in *The Wood-Worker* for September, 1939. The tree attains a height of about 120 ft and a diameter of nearly 6 ft. The trunk is unusually straight and cylindrical above the narrow buttresses, which frequently extend 9 ft above the ground, and when growing in dense stands may be clear of branches for more than 75 ft. The smooth, reddish gray bark, often speckled with moss, is about one-quarter inch thick and does not scale off.

The wood is light and soft, pale salmon pink in color, and uniform in texture. Shrinkage in drying is moderate, hence round and square logs may be imported without any danger of splitting. The sapwood is narrow and hardly distinct from heartwood. Okoumé is one of the few woods that can be peeled

in thicknesses ranging from $^1/_{128}$ to $^1/_6$ of an inch and, when put through the drier, presents perfectly smooth surfaces free from cracks and splits.

Mechanical tests have demonstrated that the finished wood is remarkably tough, strong, and stiff for its weight, and is thus well adapted for light structural work. It has fair shock-resisting capacity and is suited for use where subject to vibration and impact, as in vehicle bodies, airplanes, and packing boxes. The seasoned wood is highly elastic but splits easily.

# Energy From Matter

DISCOVERY (GREAT BRITAIN)

SCIENTISTS and engineers have long dreamed of using the latent energy of the atom. Some steps in this direction were taken with the development of the Van de Graaff electrostatic generator and the Lawrence cyclotron (see MECHANICAL ENGINEERING, Feb., 1939, page 163), both of which can generate slow-moving neutrons. Neutrons are exceedingly small subatomic particles, which have no electrical charge, and thus great penetrating power. These neutrons were used in 1934 to bombard uranium which produced radioactive elements. This was done by Dr. Enrico Fermi, winner of a Nobel prize for this achievement, who discussed the process before the Applied Mechanics Division of the A.S.M.E. during its National Meeting at Columbia University, June 14–15.

This discovery and subsequent developments to date are described by Dr. Douglas W. F. Mayer in *Discovery* for September, 1939. The principle is fairly simple. A slow neutron knocks a uranium nucleus into two approximately equal pieces, and two or more faster neutrons are discharged at the same time. These faster neutrons go on to disintegrate other uranium nuclei, and the process is self-accelerating. The remaining bombardment products were thought to be new elements, but later research by Madame Curie-Joliot, daughter of the famous Madame Curie, of Paris, Hahn and Strassman, of Berlin, and other workers, showed that these "new" elements formed from uranium were none other than the "rare earth" element lanthanum, and tellurium and iodine.

Further study, since last summer, by Dr. F. Joliot, husband of Madame Curie-Joliot, brought to light more exciting results. The neutrons used in the initial bombardment of the uranium were what are known as "thermal" neutrons, that is to say, they possessed low energies roughly equal to the thermal energy of ordinary molecules. But Dr. Joliot found that at the moment of fission of the uranium nucleus, new fast-moving neutrons were emitted, neutrons with energies of at least eleven million electron volts.

In their initial experiments, Dr. Joliot and his collaborators used only minute pieces of uranium, and consequently the neutrons, which can even penetrate metals for some distance, were able to escape. But, they asked themselves, what would happen if the neutrons were liberated in the center of a lump of uranium sufficiently large to prevent their escape? Would there be sufficient neutrons to cause further nuclei to break up, thus liberating more high-energy neutrons, and so starting a chain reaction? This brings to mind imaginative stories of scientists who start atomic reactions and cannot get them to stop, and of the fact that, even supposing only one four hundredth of the uranium is converted into energy, one ounce of uranium will produce sufficient energy to boil about one thousand tons of water. However, it is the opinion of some scientists that the formation of the other elements during the process dampens the action of the resulting neutrons.

However, experimenters in New York have demonstrated that even in its present stage, sufficient energy can be obtained from the uranium fission to cause, some distance away, the decomposition of nitrogen iodide, an unstable chemical compound. Before optimistic speculators rush on ahead, it may be pointed out that atomic power on a practical scale is still at present as far away a dream as ever, though, it may be said that the first steps toward the realization of the dream have been taken. Those who wish to speculate can ask themselves what society will make of atomic power should it come in the next century or so. Will it create a streamlined world where a pinch of salt is sufficient fuel for the *Queen Mary*, or shall there be a Wellsian chaos with each nation dropping bouquets of uranium bombs in a policy of encirclement?

# Freezing Human Diseases

REFRIGERATING ENGINEERING

A NEW field for refrigeration has been opened up by a paper, presented at the last meeting of the American Medical Association, in which Doctors Fay and Smith of Philadelphia described a "freezing" and hibernation treatment given to patients in the advanced stages of cancer, according to an article by L. Kay Wright, member A.S.M.E., in *Refrigerating Engineering*, September, 1939. Treatment by refrigeration consists of covering the nude patient with cracked ice and turning on electric fans to obtain even cooling. Thus is sleep induced, similar to drowsiness exhibited by a freezing person. Patients report no pain.

In about three hours the body temperature is lowered to below 90 F. When it reaches a temperature of 89 F, the ice is removed and the patient is kept in a cold room, sleeping much as a bear hibernating in his cave. After the proper period he is awakened by hot applications and hot coffee, with no memory of what happened or fear of repeating the process.

The part which puzzles even the doctors is that the pulse beat nearly disappears, the electrocardiograph alone being able to detect it, and indicating it to be beating with perfect rhythm. Bowels, kidney, and digestive organs cease functioning, ordinarily a signal of approaching death. Analysis of the blood shows that there are no waste products.

Means of improving the method of application as described, by the use of cracked ice, have been offered by enterprising mechanical engineers in the shape of a refrigerated blanket. This device is a partner to a product already on the market, an air-conditioned blanket. Used widely in hospitals for fever patients, this blanket is piped to a cold-air supply which is fed through a porous lower side toward the patient's body.

Dr. Ralph S. Willard, of California, claims to have placed a Rhesus monkey under ether, injected a series of saline solutions into its blood stream to prevent coagulation, and to have allowed liquid carbon dioxide to gush out of a refrigerant cylinder over the animal's head to bring about rapid freezing of the brain tissues. Where rapid freezing of tissue occurs, the tiny sacs and structures are not ruptured or destroyed, as is the case when slow freezing is resorted to, he reports. Ten seconds after freezing the head and brain the entire body was immersed in liquid air. The temperature of liquid carbon dioxide is —110 F and that of liquid air is —310 F.

The stiff, frozen body of the monkey was then placed in a low-temperature chamber for a period of three days, at the end of which time it was removed to a warming chamber. After ten hours a series of injections containing adrenalin, interior and exterior pituitary fluid, and exhormone pituitary fluid were given. Oxygen was also administered. The monkey revived. This method has not yet been applied to human beings.

# LETTERS AND COMMENT

*Brief Articles of Current Interest, Discussion of Papers in Previous Issues*

## The Pelton Water Wheel

To the Editor:

Dr. Durand's paper[1] provides an authoritative documentation on the American contributions to the development of the Pelton type of turbine and is consequently of great value to those who are interested in the history of the art.

The writer had the opportunity, while in France as a Freeman scholar, to become familiar with some of the eighteenth-century literature dealing with hydraulic machinery. As some of this material is not easily available, it is felt that it will be worth while to supplement Dr. Durand's excellent article with a short résumé showing the apparent state of development at this time (about 1700 to 1737).

Probably of most interest is a short section of a book[2] by Belidor, a free translation of which follows:

In Provence and a large part of Dauphine the water mills are very simple, consisting only of a horizontal wheel *D*, 6 or 7 "pieds" in diameter,[3] the paddles of which are made in the shape of a spoon so as to receive the impact of the water, usually flowing in a trough *A*, Fig. 1. The axle *E*, leading to the upper millstone, alone communicates movement to the stone and I do not believe it is possible to construct a mill at less cost. It is true that a fall similar to that shown, which is a type quite common in that country, is necessary.

The wheel turns on a pivot in a socket placed in the middle of a crossbeam of the chassis *OF*, which serves to regulate the millstones through its raising and lowering by means of the screw *G* and nut *H*.

The wheels of this type have their spoons attached to the axle by a tenon and peg, and are reinforced underneath by members serving to hold them together. Others are of the type shown in the plan and elevation, *M* and *N*, which are clear without further explanation.

When the miller wishes to stop the mill, he may do so without leaving the building, by pushing the handle *I* to lower the flap *L*, which, with the lever *K*, is attached to a swivel to facilitate the movement. At a higher level there is a gate at the canal entrance, as shown at *C*, to prevent the entrance of water into the trough and its loss by the overflow which would otherwise occur when *L* was closed. When the wheel is not operated for some time, the water is led to a reservoir to create a supply for future use.

The mill is at Briancon; water from the Durance operates three similar wheels in the same building.

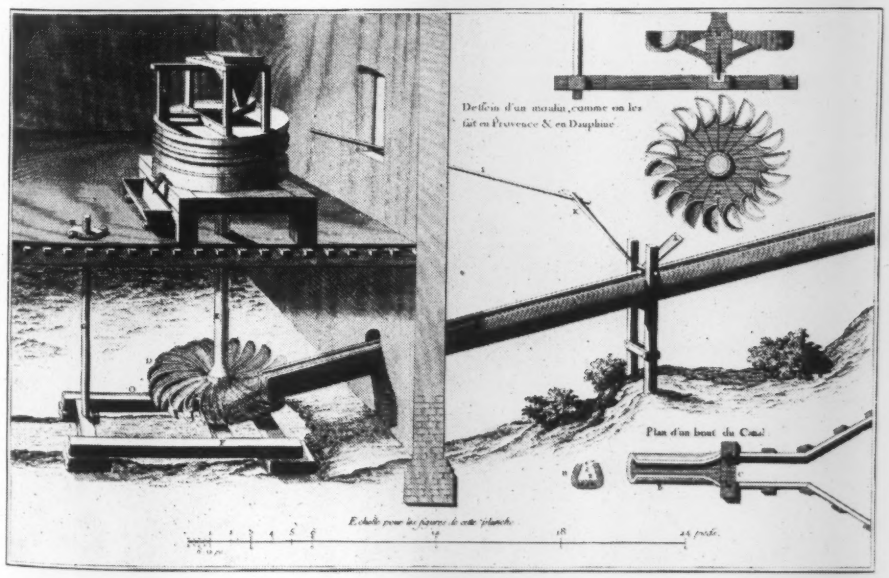

Dessein d'un moulin, comme on les fait en Provence & en Dauphine
Plan d'un bout du Canal
Echelle pour les figures de cette planche.
pieds

FIG. 1

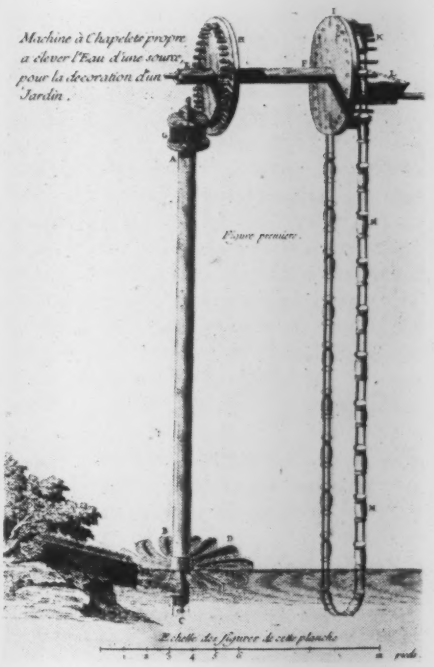

Machine à Chapelets propre a élever l'Eau d'une source, pour la décoration d'un Jardin.
Figure premiere.
Echelle des figures de cette planche
pieds

FIG. 2

In the same volume, on page 369, Belidor writes of the use of chain pumps for elevating water for various purposes, as follows:

It is supposed that water from a spring or a stream is led to turn a horizontal spoon wheel *BD* (Fig. 2) by impact .....

The remainder of the section, not translated here, gives the dimensions and details of the apparatus.

Commenting upon Belidor's work, DuBois, in his recent book[4] writes:

Here we note a partial-admission wheel which is clearly the grandmother of the present Pelton turbine. Belidor already employs the expression "spoons" to designate the paddles.

DuBois continues, on page 57 of his book:

I have had the opportunity of seeing several of these antique mills, with similar wheels,

[1] "The Pelton Water Wheel," by W. F. Durand, Mechanical Engineering, June and July, 1939, pp. 447 and 511.

[2] "Architecture Hydraulique," by Bernard Forest de Belidor, Jombert, Paris, 1737, vol. 1, book 2, p. 301, section 666.

[3] The eighteenth-century "pied" in France was equal to 324 or 325 mm.

[4] "Un précurseur, Belidor, Notes sur L'Architecture Hydraulique," by L. DuBois, Editions La Concorde, Lausanne, 1931, p. 54.

in operation in the Caucasus, Greece, and Macedonia. In one of them, the water arrived at the turbine, not in an open channel, but by a pressure pipe of wood, with iron hoops.

Montaigne noted mills of this type in the course of his voyage through Switzerland, Germany, and Italy in 1580, and since he had not had the opportunity of seeing similar ones in Gascony, he gave the following description of one of these mills situated in Bavaria, between Lindau and Augsbourg.

The short description which follows concerns a mill supplied from an elevated source by a conduit; but gives no details of the wheel itself.

It would seem from this information that the origin of the forerunner of the Pelton wheel is somewhat obscure. Montaigne's observation of spoon wheels in Switzerland, Germany, and Italy in 1580 would indicate that, even at that date, this type of wheel was quite common, and there seems to be little doubt that the invention of the spoon wheel must have antedated 1580 by a considerable period.

To those who are interested in the history of turbine development, there is much of value to be found in a small booklet[5] by Crozet-Fourneyron which, while only partially complete, nevertheless contains a wealth of information not easily obtainable elsewhere.

MARTIN A. MASON.[6]

## The Tilt Hammer

TO THE EDITOR:

In MECHANICAL ENGINEERING, May, 1939, page 382, appeared two interesting pictures of the old Abbeydale Works, Sheffield, England. These pictures, and especially that showing the tilt hammers, prompt me to remind your readers that such hammers, but in slightly better state of repair, were the most powerful available until James Nasmyth's invention of the mighty steam hammer just one hundred years ago.

The tilt hammer, motivated by water or manual power, had served Europe for centuries without major improvement, and it was an important tool in the manufacture of such engines as those of Newcomen, Watt, and our own Oliver Evans, or such locomotives as Trevithick's and Stephenson's.

It is also interesting to record that about 1750 in the reign of George II, the British Government passed "An Act to encourage the Importation of Pig and Bar Iron from His Majesty's Colonies in America; and to prevent the Erection of any Mill or other Engine for Slitting or Rolling of Iron; or any Plating Forge work with a Tilt Hammer; or any Furnace for making Steel in any of the said Colonies." The shortage of wood curtailed iron production in England, but it was felt that other American ironwork would be detrimental to English trade.

The accompanying illustration, dated 1810, shows a forge similar in many respects to the Abbeydale Works, but of somewhat smaller dimensions. The water wheel *B* drives cams which "blow" each of the cylindrical bellows in repeated succession. The tilt hammer *L* is not depressed at the fulcrum end by the pegged water-wheel shaft as at Abbeydale, but instead is raised by the pegs, pressed tightly against the heavily weighted spring *V*, until released by the revolution of the peg wheel.

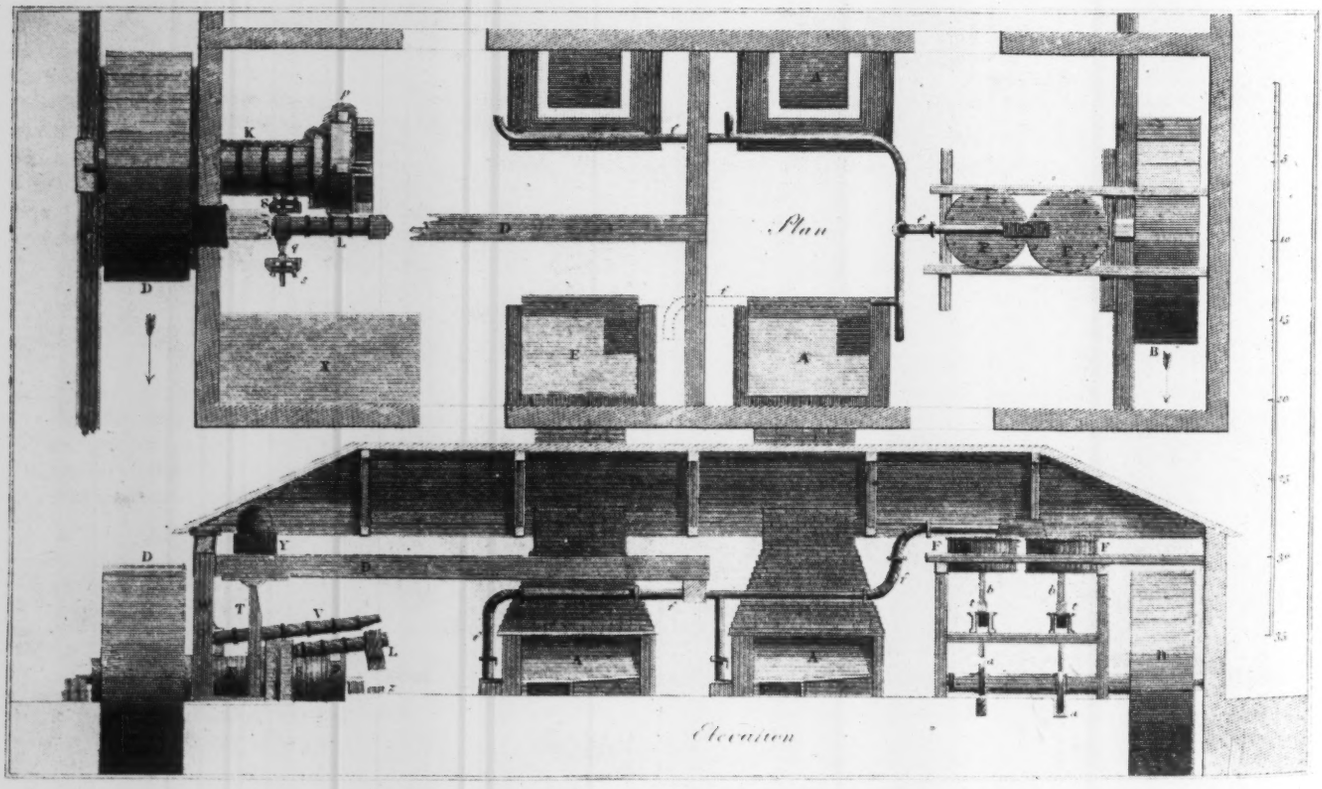
Nasmyth was prompted to invent his steam hammer by Francis Humphries whose work was of such dimensions as made the Tilt useless. Its immediate success in England was noted by one George Humphreys of Philadelphia, who introduced the steam hammer to this country. Neither gentleman was apparently related to his namesake—

CYRIL G. R. HUMPHREYS.[7]

[5] "Invention de la Turbine," by Marcel Crozet-Fourneyron, obtainable from Librairie Beranger, Paris, France.

[6] Assistant Hydraulic Engineer, National Bureau of Standards, Washington, D. C. Jun. A.S.M.E.

[7] Consolidated Edison Company of New York, Inc., New York, N. Y. Mem. A.S.M.E.




DRAWING OF A FORGE AND TILT HAMMER, 1810

# Creep in Tubular Pressure Vessels

TO THE EDITOR:

The data presented by Professor Norton[8] are of special interest since they serve to substantiate further a hypothesis formulated by the writers from a comparison of the creep of tubular specimens under internal pressure with the creep of conventional tension specimens. The writers' test data on the creep of tubes subjected to internal pressure and laboratory tensile tests, both of which extended for 5000 hours or longer, were described in a recent paper.[9]

In reviewing this paper the writers were impressed with the similarity in behavior of tubes which were tested under closed-end conditions to that of the sections of tubing which were subjected to service tests by the writers' company. It had been supposed that the effect of a guard sleeve and minor bending moments would prevent a true closed-end condition being realized in these latter tests. Both sets of tests, however, are found to be mutually confirmatory and taken together appear to the writers to afford a basis for the following statements:

(1) For each material there are combinations of stress and temperature for which diametral or circumferential creep of a tube subjected to internal pressure will be the same as the elongation of a tension specimen under a tensile stress equal to the hoop stress in the tube. These combinations of stress and temperature are *qualitatively* represented by the curve of Fig. 1, which may be termed the "equicreep" line or band.

(2) For combinations of stress and temperature which fall in the region above this equicreep line, the circumferential creep of tubes which are subjected to internal pressure is less than the creep of conventional tension specimens.

(3) For combinations of stress and temperature which fall in the region below this equicreep line, the circumferential creep of tubes which are subjected to internal pressure is greater than creep of conventional tension specimens.

The hypothesis set forth in these statements is of great assistance in reconciling the behavior of tubes subjected to internal pressures producing rapid rates of diametral extension with the different behavior of tubes subjected to internal pressures producing slow rates of diametral extension as compared to the corresponding laboratory tension specimens. It also serves to explain why conclusions drawn from experiments on lead tubes are apt to be misleading when applied to the design of pipe and tubing for high-temperature service. Professor Norton's conclusion that tubular specimens creep at about half the rate of the tensile specimens under the same stress, while properly qualified, appears to the writers to have been influenced unduly by tests on lead tubes.

An examination of Fig. 1 will show that allowable design stresses for carbon-molybdenum pipe and tubes, such as given in the A.S.M.E. Boiler Code, fall in the region in which creep of tubes subjected to internal pressure is greater than the creep of conventional tension specimens. On the other hand, oil-still tubes if designed on the basis of 1 per cent in 10,000 hours may (and if some of the higher stress values reported for C-Mo tubes are used, they most surely will) fall in the region above the equicreep line where the diametral

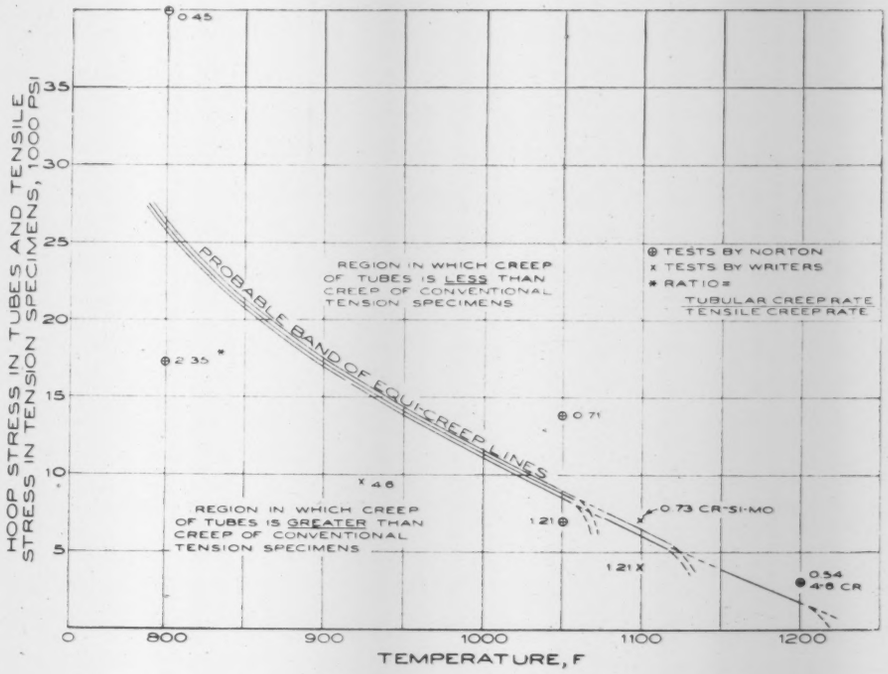

HOOP STRESS IN TUBES AND TENSILE STRESS IN TENSION SPECIMENS, 1000 PSI
TEMPERATURE, F
PROBABLE BAND OF EQUICREEP LINES
REGION IN WHICH CREEP OF TUBES IS LESS THAN CREEP OF CONVENTIONAL TENSION SPECIMENS
REGION IN WHICH CREEP OF TUBES IS GREATER THAN CREEP OF CONVENTIONAL TENSION SPECIMENS
⊕ TESTS BY NORTON
x TESTS BY WRITERS
* RATIO = TUBULAR CREEP RATE / TENSILE CREEP RATE
0.45
2.35 *
0.71
4.6
1.21 ⊕
0.73 CR-SI-MO
1.21 X
0.54
4-6 CR

FIG. 1 PROBABLE BAND OF EQUICREEP LINES FOR TUBES AND TENSION SPECIMENS

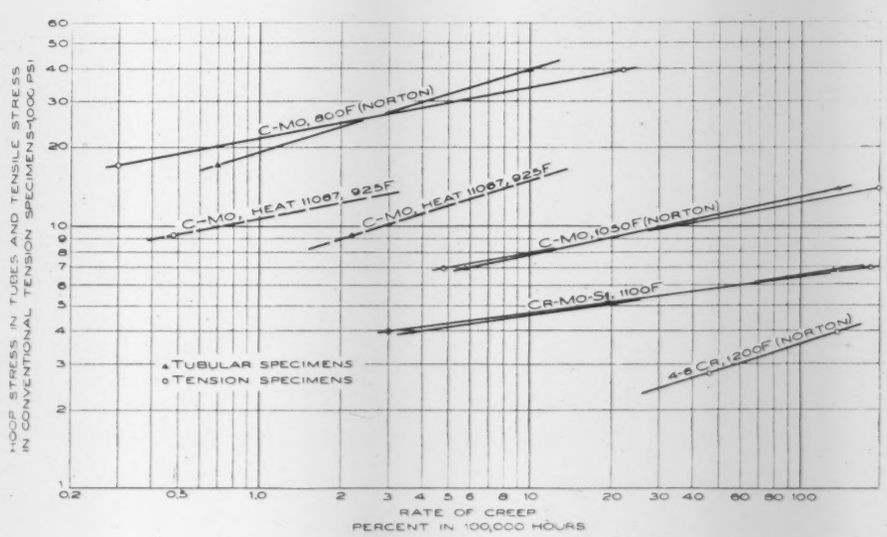

HOOP STRESS IN TUBES AND TENSILE STRESS IN CONVENTIONAL TENSION SPECIMENS-1000 PSI
RATE OF CREEP PERCENT IN 100,000 HOURS
C-MO, 800F (NORTON)
C-MO, HEAT 11087, 925F
C-MO, HEAT 11087, 925F
C-MO, 1050F (NORTON)
CR-MO-SI, 1100F
4-6 CR, 1200F (NORTON)
▲ TUBULAR SPECIMENS
○ TENSION SPECIMENS

FIG. 2 CIRCUMFERENTIAL AND TENSILE CREEP RATES

[8] "Creep in Tubular Pressure Vessels," by F. H. Norton, Trans. A.S.M.E., vol. 61, April, 1939, pp. 239–245.

[9] "High-Temperature-Steam Experience at Detroit," by R. M. Van Duzer, Jr., and Arthur McCutchan, Trans. A.S.M.E., vol. 61, July, 1939, pp. 383–401.

extension may be only from one half to three quarters as great as predicted from tensile creep tests.

The experimental basis for this hypothesis is given in Fig. 2. This log-log plot which corresponds to Fig. 11 of the author's paper was plotted from Tables 2 and 3 of that paper.

Attention is called to the fact that the writers have replotted the tensile test for the 39,170-psi stress for C-Mo steel at 800 F at 22 per cent instead of at 12 per cent as inadvertently plotted by the author in Fig. 11. They also have included in Fig. 2 the creep value of 10 per cent for the tubular specimen at this stress given by the author in Table 2 of the paper.

The writers' test results on C-Mo steel at 925 F and Cr-Si-Mo at 1100 F also have been plotted on this chart. These results are given in Tables 1 and 2.

The same reversal of the relation between creep of tubular and tension specimens with increase in stress as shown by Professor Norton's results at 800 and 1050 F for C-Mo steel is shown by the writers' data in their curves for Cr-Si-Mo at 1100 F. The author's value for the interval from 1800 to 3900 hr for the C-Mo tube at 1050 F has been omitted from this comparison since there was no similar time interval for the tensile test with which it could be compared. From the writers' experience in such testing, it is considered essential to use substantially the same time interval in these comparisons. The creep rate for Cr-Si-Mo at 1100 F under a stress of 3930 psi, as determined from the 8000-to-16,000-hr interval given in Table 1, likewise has been omitted from the comparison for lack of a comparable laboratory determination for the tension specimen.

The writers' tests at 925 F were with a working stress of 9220 psi which is only slightly greater than the Boiler Code figure for allowable stress for C-Mo tubing. Creep was much greater than predicted from laboratory tensile determinations. Both the stresses used by the author in testing 4–6 Cr at 1200 F were in the higher stress range, and creep of the tubular specimens was accordingly less than for the tension specimens. The location of the equicreep line for 4–6 Cr material has been sketched in on Fig. 1 in a purely arbitrary manner. It also is a matter of conjecture whether the equicreep line for a given material becomes asymptotic to the temperature abscissa or turns down to meet it. Both courses are indicated in Fig. 1.

The writers do not at the moment have any satisfactory explanation to offer as to why tubes subjected to internal pressure behave differently under high rates of creep than when the rates are lower as compared to laboratory tension specimens. They do wish to point out, however, that the experimental evidence so far produced indicates such a difference does exist, and that it has an important bearing on design and on conclusions that may be drawn from field check measurements on pipe and tubes under service conditions. It might be possible under certain conditions of loading to have a tube subjected to a range of stress in which the rate of creep would vary from as much as five or more times the tensile rate to less than one half the tensile rate. It would assist materially in developing this theory if the author could run a check test on C-Mo steel at 925 F using stresses of say 9000 and 20,000 psi in order to be well within each of the stress regions indicated in Fig. 1.

The writers wish to emphasize that the equicreep line or band of lines for different materials and the regions in which creep of tubes subjected to internal pressure is indicated to be greater or less than that of tensile specimens will require many more tests before the hypothesis advanced by the writers can be accorded the dignity of being called a theory.

Professor Norton's test data have been of inestimable value in reconciling some of the peculiarities observed in the writers' service tests and it is hoped that his experiments will be continued.

R. M. VAN DUZER, JR.[10]
ARTHUR MCCUTCHAN.[11]

TABLE 1 TUBULAR SPECIMENS

| Steel | Temp, F | Circumferential stress, psi | Circumferential creep, % per 100,000 hr | Time interval from which rate was computed, hr |
|---|---|---|---|---|
| C-Mo, heat 4129 | 925 | 9220 | 1.47 | 3000–6000 |
| C-Mo, heat 11067 | 925 | 9220 | 2.2 | 3000–6000 |
| Cr-Mo-Si[a] | 1100 | 3930 | 3.63 | 3000–6000 |
| Cr-Mo-Si[a] | 1100 | 3930 | 3.49 | 8000–16,000 |
| Cr-Mo-Si[a] | 1100 | 6780 | 133.0 | 5000–8000 |

[a] 1.24 per cent Cr, 0.58 Mo, 1.4 Si.

TABLE 2 LABORATORY TENSION SPECIMENS

| Steel | Temp, F | Stress, psi | Creep rate, % per 100,000 hr | Time interval from which rate was computed, hr |
|---|---|---|---|---|
| C-Mo, heat 4129 | 925 | 9250 | 0.02 | 3000–6000 |
| C-Mo, heat 11067 | 925 | 9250 | 0.48 | 3000–6000 |
| Cr-Mo-Si | 1100 | 4000 | 3.0 | 2000–6000 |
| Cr-Mo-Si | 1100 | 7000 | 182.0 | 5000–8000 |

## Centrifugal-Machine Applications

TO THE EDITOR:

The writer is sorry that he missed the paper[12] by Mr. Pecker until after publication, as he has a few ideas on the subject that might be of interest.

It would seem preferable to express the centrifugal force by the formula

$$C = w^2 Wr$$

as used by the writer in a previous paper, indicating that the force is proportional to the square of the angular velocity, the distance from the axis of rotation, and the weight of the substance. The author uses the formula

$$F = KN^2R$$

This does not take into consideration the weight of the material which is of great importance in the calculations.

Concerning the extractions of solids from a slurry of 98 per cent moisture, the proper machine and equipment should extract to below 75 per cent. The writer's experience is that rather than extract to 75 per cent moisture and then use a settling tank it would be more advantageous to disregard centrifugals and leave the whole process to the settling tank.

It would have been of interest if some of the vertical machines with underneath drives had been shown. Such machines are used extensively because of greater ease in charging and discharging and because there is no danger of contamination of the contents of the drum from impurities dropping from the drive as often occurs with top-driven machines.[13] It would also have been interesting if the author had given some data on the sizes

[10] Engineer, Production Department, The Detroit Edison Company, Detroit, Mich. Mem. A.S.M.E.

[11] Engineer, Engineering Division, The Detroit Edison Company. Jun. A.S.M.E.

[12] "Problems and Trends in Centrifugal-Machine Applications," by Joseph S. Pecker, Trans. A.S.M.E., July, 1939, pp. 415–422.

[13] "Centrifugal Machines and Their Uses," by Bartholomew Viola, Trans. A.S.M.E., vol. 24, 1903, pp. 216–244.

and production capacities of the various machines.

In regard to the De Laval and Sharples cream separators, it might be mentioned that this construction was used in the Alpha separator about 50 years ago (Bechtolsheim patent) and is still a favorite type.

In spite of the fact that the writer wishes that there could have been more detailed information and drawings given he feels that great credit is due the author for his efforts.

BARTHOLOMEW VIOLA.[14]

## For and Against

TO THE EDITOR:

I have just finished reading the communication[15] from Mr. Sanford A. Moss published in the August issue, and may I say that I agree heartily with Mr. Moss in saying that the editor can be proud of the papers he has published on strictly engineering subjects. I would like to go further, however, and say that, in my opinion, the editor can also be proud of the papers he has published on economic and social matters.

I am sure that it would be very difficult to say whether the so-called nontechnical papers which have been published in MECHANICAL ENGINEERING in the last few years "have had an effect on the world's progress worth the cost to the Society of printing them." I do feel very strongly however, that unless knowledge of the social and economic needs of the day is better understood, and that by more people, and unless such needs are considered in all phases of human activity, there may be grave danger of failure to realize the full benefits of technical progress which engineers have made available.

Perhaps I may be pardoned for quoting from a critique of Professor Cabot of Harvard University in which he was discussing papers presented at the Seventh International Management Congress dealing with administrative and financial controls:

> We may say: first, that the business administrator has shown ability of a high order in dealing with what might be called his "inanimate material." The existence of large-scale industry proves this. Second, he is beginning to recognize that "the society within his firm" and "the great society" outside of it are composed of human beings about whom he does not know enough. But he is making progress by applying scientific methods of observation and research to the "society within the firm." Third, in his dealings with "the great society" he still goes largely by "smell." In act, in this field he closely resembles a blind dog in a meat shop. Fourth, he has violated the principle of balance, . . . . . by allowing himself to become engrossed in the fascinating techniques of . . . . . administration, while he has neglected the social and human problems of his business, which are its foundation. Under these circumstances, he must now focus his attention on his social problems for the purpose of developing adequate techniques of observation and treatment. Only thus can he restore the balance which is an essential condition of the life of large-scale business.

In other words, my plea to you, Mr. Editor, is that you continue your present policy of publishing not only excellent papers on strictly engineering subjects, but likewise excellent papers on social and economic matters.

A. A. TALMAGE.[16]

[14] Brooklyn, N. Y. Member A.S.M.E.

[15] MECHANICAL ENGINEERING, August, 1939, page 622.

[16] Budget Department Head, Ebasco Services, Inc., New York, N. Y. Mem. A.S.M.E.

TO THE EDITOR:

I certainly want to add my small voice to the protest raised by Sanford A. Moss in his letter[15] in the August issue which objects to the printing of so many articles dealing with sociology.

In these days of brain trusters, when one must spend so much time combatting ill-advised and crack-pot legislation, it is very disconcerting to slip into an easy chair with your favorite magazine and find that it, too, is wandering far from its proper field into what at best is only theory.

Please give us more articles dealing with the definite things in which we are interested so that our magazine may nearer live up to its title MECHANICAL ENGINEERING.

M. E. KLINE.[17]

[17] Sales Engineer, Union Lumber Company, San Francisco, Calif. Mem. A.S.M.E.

# REVIEWS OF BOOKS

## Medicolegal Phases of Occupational Diseases

MEDICOLEGAL PHASES OF OCCUPATIONAL DISEASES. By C. O. Sappington, Industrial Health Book Co., Chicago, 1939. Cloth, $5\frac{1}{2} \times 8\frac{1}{2}$ in., 405 pp., illus., charts, tables, $2.75.

REVIEWED BY THEODORE F. HATCH[1]

IN 1928 only ten states made any provision for occupational-disease coverage under their workmen's compensation laws. By 1938, however, the number had doubled and several additional states had under consideration proposed laws respecting health hazards in industry. During this same ten-year period the number of states engaged in the study and control of industrial health hazards increased many fold.

In the early part of the decade under consideration, before new legislation had been adopted, there was frequent recourse to the courts for the settlement of claims with respect to occupational diseases which were not covered by existing compensation laws.

Because of these rapid changes in and extension of state laws, much interest centers around the medicolegal phases of occupational diseases. Hence, the present volume is a valuable contribution to the literature. Dr. Sappington has made no attempt to prepare a treatise on industrial hygiene but has presented in outline form in Part 1 some of the more important aspects of the problem in industry including the causes of occupational diseases, standards of permissible exposure, procedures for conducting industrial-hygiene surveys and technical methods of air analysis, and finally the control of occupational disease.

The remaining three parts have to do with insurance, medical, and legal problems.

For insurance carriers, the author recommends the same specific approach to the evaluation of health hazards that are followed in basic scientific studies of hazards with close cooperation between the engineering, medical, claim, and other departments of the organization. It is emphasized that physical inspections alone do not yield sufficient information to permit a final evaluation of occupational disease hazards. The importance of the application of preventive measures can never be overemphasized by the insurance carrier.

The function of the industrial physician is to discover and treat occupational diseases and to establish and conduct the necessary program of medical prevention of such diseases. An important activity in connection with the latter is, of course, the routine physical examinations of workers and their placing in occupations suited to their physical conditions. While the industrial physician is not ex-

[1] Associate Dust Control Engineer, Division of Industrial Hygiene, N. Y. State Department of Labor, New York, N. Y. Mem. A.S.M.E.

pected to become an engineer, he must be familiar with and recognize the working conditions which lead to the development of occupational disease and must also have knowledge of the basic engineering measures of prevention.

From the medicolegal point of view the physician must be capable of establishing the causal relation between health damage on the one hand and working conditions on the other. Another important medicolegal function of the physician is to evaluate the extent of disability in occupational-disease cases for the proper adjustment of compensation claims.

The section devoted to legal questions includes at the outset a discussion of four questions which must be answered before intelligent consideration can be given to the merits of a given claim. Briefly these are:

1 Do the working conditions present an actual health hazard?

2 Has the employee a real occupational disease, as he claims?

3 Was the disease contracted while working for the employer against whom the claim is made?

4 Is the employee disabled from the effects of the disease for which he asks compensation?

The author makes a plea for the rational approach to the problem based upon these simple questions and considers further the procedure for preparing evidence which will yield definite answers to them. Many valuable suggestions are given with respect to the nature of medical and other testimony required in the proper presentation of a case.

The section on legal matters is completed with a review of existing compensation laws and progress in occupational-disease legislation.

Seven appendixes are included in the volume, the contents of which are self-evident from their titles: occupational record; abstracts of state laws; scheduled diseases; abstracts of legal decisions; legislative suggestions—American Bar Association; suggested schedule law—American Public Health Association; digest of Workmen's Compensation laws by states.

## Books Received in Library

ATM (Archiv für technisches Messen), Lieferungen 94–96, April–June, 1939. R. Oldenbourg, Munich and Berlin, 1939. Paper, 8 × 12 in., illus., diagrams, charts, tables, 1.50 rm each. Three numbers of a monthly publication containing classified articles upon various types of apparatus and methods for technical measurements. Certain numbers also contain descriptions of specific instruments manufactured by German companies.

DAS ABC FÜR DEN MODELLBAU. (Werkstattbücher, Heft 72.) By E. Kadlec. Julius Springer, Berlin, 1939. Paper, 6 × 9 in., 63 pp., tables, diagrams, 2 rm. This handbook gives a concise, practical description of patternmaking methods, intended for the workman. Materials and tools, molding methods, and the construction of patterns and cores are considered. Many special forms of patterns are described. The book is profusely illustrated.

ATOMS IN ACTION, the World of Creative Physics. By G. R. Harrison. William Morrow & Co., New York, 1939. Cloth, 6 × 9 in., 370 pp., illus., diagrams, $3.50. This is an unusually able and authoritative presentation of what modern physicists think and do, and of the more important applications of their work in daily life. The book is eminently readable and interesting, as well as accurate, and is endorsed by eminent physicists.

DER CHEMIE-INGENIEUR, edited by A. Eucken and M. Jakob. Bd. 3, Chemische Operationen. Part 4, Hochdruckoperationen, by D. M. Newitt, G. Schneider, G. Natta, and G. Roberti. Akademische Verlagsgesellschaft, Leipzig, 1939. Cloth and paper, 7 × 10 in., 267 pp., illus., diagrams, charts, tables; cloth, 28 rm; paper, 26 rm. This latest addition to a set of reference works for the chemical engineer covers high-pressure operations. The several chapters, each written by an authority, deal with the following topics: The calculation and construction of high-pressure apparatus; the characteristics of high-pressure reactions in liquid phase; autoclave technique; high-pressure processes for continuous operation, including the use of catalysts; and the fundamentals and industrial operation of the cracking process.

DIE DAMPFKESSEL UND FEUERUNGEN EINSCHLIESSLICH HILFSEINRICHTUNGEN, 2 volumes. (Sammlung Göschen, Bd. 9 and Bd. 521.) By W. Marcard. Walter de Gruyter & Co., Berlin, 1939. Cloth, 4 × 7 in., diagrams, charts, tables; part 1, 136 pp.; part 2, 138 pp., 1.62 rm each. These two small volumes provide a brief, but comprehensive account of modern steam-boiler practice. Volume one covers the theoretical principles, combustion, and heat transfer; volume two, the types of boilers, superheaters, feedwater heaters, and air heaters, as well as boiler-plant design.

DISEASES OF ELECTRICAL MACHINERY. By G. W. Stubbings. Chemical Publishing Co., New York, 1939. Cloth, 5 × 8 in., 219 pp., diagrams, $3. This small manual is intended for power-plant engineers and electricians. The defects that arise in the operation of electrical machinery are discussed, their underlying causes explained, and practical directions given for their location and rectification.

ENGINEERING PHYSICAL METALLURGY. By R. H. Heyer. D. Van Nostrand Co., New York, 1939. Cloth, 6 × 9 in., 549 pp., illus., diagrams, charts, tables, $4.50. The aim of this book is to provide treatment of the subject, intended for those making their first acquaintance with engineering metals and alloys. A wide range of materials is discussed, including pure metals and alloys; also processes of hot and cold reduction, heat-treatment, welding, machining, etc. Each chapter has a bibliography.

FRÄSEN, edited by Wanderer-Werke Aktiengesellschaft, Siegmar-Schönau bei Chemnitz, 1939. Julius Springer, Berlin. Cloth, 9 × 12 in., 89 pp., illus., tables, diagrams, cloth 6.60 rm. Milling machines form the subject of this memorial publication of a large German machine works. The first four chapters cover milling theory, rules for proper milling work, and feed and speed calculations. Chapters 5 and 6 contain descriptions of actual jobs, and of machines and supplementary equipment manufactured by the company.

GASOLINE AUTOMOBILE. (Engineering Education Series.) By B. G. Elliott and E. L. Consoliver. Fifth edition. McGraw-Hill Book Co., New York and London, 1939. Cloth, 6 × 10 in., 754 pp., illus., diagrams, charts, tables, $4. This well-known text aims to present the fundamental principles and ideas upon which motor vehicles are designed, constructed, and operated. In the new edition attention is given to the automotive-type Diesel engine and the low-compression spark-ignition oil engine. The material on tractors and automatic transmissions has been enlarged and the book brought up to date throughout.

Great Britain, Department of Scientific and Industrial Research. METHODS FOR THE DETECTION OF TOXIC GASES IN INDUSTRY. Leaflet No. 3, Sulphur Dioxide. 1938. 6 pp., 2s 6d. Leaflet No. 4, Benzene Vapour. 1939. 9 pp., 3d. Leaflet No. 5, Nitrous Fumes. 1939. 9 pp., 3d. His Majesty's Stationery Office, London. Paper, 6 × 10 in., diagrams, tables. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, Leaflet 3, $0.75; Leaflet 4, $0.10; Leaflet 5, $0.10.) These leaflets contain approved methods for testing the freedom from various gases of enclosed places which workmen are about to enter. The directions are full and simple, and have proved satisfactory under practical conditions.

Great Britain, Department of Scientific and Industrial Research. REPORT 1937–1938. His Majesty's Stationery Office, London, 1939. Paper, 6 × 10 in., 203 pp., charts, 3s. (Obtainable from British Library of Information, 50 Rockefeller Plaza, New York, $0.90.) The report reviews the work of the various committees and associations and so affords a general survey of the scientific and industrial research work carried out in Great Britain during the year. Appendixes give directories of the departments and associations and their officers, lists of the publications of the year, expenditures, etc.

HANDBOOK OF CHEMISTRY, compiled and edited by N. A. Lange, assisted by G. M. Forker, with an Appendix of Mathematical Tables and Formulas, by R. S. Burington. Third edition, revised and enlarged. Sandusky, Ohio, Handbook Publishers, Inc., 1939. Cloth, 5 × 8 in., 1543 pp., Appendix, 249 pp., diagrams, charts, tables, $6. This useful book contains an unusually extensive collection of chemical and physical data used by chemists, engineers, and physicists. The data have been taken from reliable sources and are presented in convenient form for ready reference. This edition has been extensively revised and materially extended.

HANDBOOK OF HYDRAULICS. By H. W. King. Third edition. McGraw-Hill Book Co., New York and London, 1939. Leather, 4 × 7 in., 617 pp., diagrams, charts, tables, $4. "The outstanding feature of this edition is," according to the preface, "the complete revision and extension of the two chapters on open channels, one dealing with uniform flow and the other with nonuniform flow, adding in all

ninety-four pages to the text and tables." The book is intended to provide in compact form the tables and reference data commonly needed for the solution of hydraulic problems, and to serve as a textbook for advanced classes.

HEATING AND AIR CONDITIONING. By J. R. Allen and J. H. Walker. Fifth edition. McGraw-Hill Book Co., New York and London, 1939. Cloth, 6 × 9 in., 593 pp., illus., diagrams, charts, tables, $4.50. The purpose of this textbook is to provide a comprehensive account of the theory underlying heating and air conditioning, together with practical information on design, equipment, etc. The work is adapted for use in engineering schools or by individuals for home study. This edition has been revised throughout and considerably enlarged.

MANUAL OF FOUNDRY PRACTICE. By J. Laing and R. T. Rolfe. Chemical Publishing Co., New York, 1939. Cloth, 6 × 9 in., 312 pp., illus., diagrams, charts, tables, $7.25. The basic principles of molding and coremaking occupy the first few chapters of this manual. Following these a comprehensive treatment of advanced technique is presented, with particular attention to special design problems. Both cast-iron and nonferrous practice are considered, including some information as to their metallurgy, but steel founding has been omitted.

MATHEMATICS OF STATISTICS, Parts 1 and 2. By J. F. Kenney. D. Van Nostrand Co., New York, 1939. Cloth, 6 × 9 in.; part 1, 248 pp.; part 2, 202 pp.; diagrams, charts, tables, $4. An elementary textbook which calls for no mathematics beyond the ordinary freshman course in college algebra, this work aims to provide an acquaintance with the fundamental principles and concepts which underlie the applications of statistics in various fields.

PATENTS AND THE PUBLIC INTEREST. By H. A. Toulmin. Harper Bros., New York and London, 1939. Cloth, 6 × 9 in., 205 pp., illus., charts, maps, diagrams, $2.50. In this volume Mr. Toulmin surveys our patent system critically and suggests lines of improvement. He discusses the reasons for it, the relation between patents and such public problems as patent pools, unemployment and patent suppression, and analyzes various proposals for its reform. In the final section the author describes the results of various modern inventions.

PETROLEUM PRODUCTION ENGINEERING, Oil Field Exploitation. By L. C. Uren. Second edition. McGraw-Hill Book Co., New York and London, 1939. Cloth, 6 × 9 1/2 in., 756 pp., illus., diagrams, charts, tables, $5. This volume is a revised and much extended edition of the part of "Petroleum Production Engineering" that discusses oil-field exploitation. It affords a survey, in considerable detail, of the technology of oil production, covering the methods and equipment, and the physical principles that control the recovery of petroleum from its reservoir rocks. Each chapter has a selected list of references.

SEVEN PLACE NATURAL TRIGONOMETRICAL FUNCTIONS. By H. C. Ives. John Wiley & Sons, New York, 1939. Cloth, 4 × 7 in., 222 pp., diagrams, charts, tables, $2.50. These tables have gone into a second printing, in which certain revisions have been made, particularly in the tables for the time of culmination and elongation of Polaris. The book provides a compact collection for field and office use by surveyors, especially with calculating machines.

STANDARD CHEMICAL AND TECHNICAL DICTIONARY. By H. Bennett. Chemical Publishing Co., New York, 1939. Cloth, 6 × 10 in., 638 pp., diagrams, $10. This dictionary is a useful addition to the chemist's library. Over 25,000 terms relating to chemistry and the allied sciences are listed, with concise definitions. Many trade names, abbreviations, and symbols are included, as well as explanations of the nomenclature of organic compounds and radicals.

STEAM, AIR, AND GAS POWER. By W. H. Severns and H. E. Degler. Third edition. John Wiley & Sons, New York, 1939. Cloth, 6 × 9 in., 511 pp., illus., diagrams, charts, tables, $4. The purpose of this textbook is "to present illustrations, descriptions, and underlying theory of construction, application, and performance of modern heat-power plants and their correlated equipment." Numerous changes, reflecting recent progress in this field, have been made in this edition.

Theorie und Berechnung der KOHLENSTAUBFEUERUNGEN. By W. Gumz. Julius Springer, Berlin, 1939. Paper, 6 × 10 in., 92 pp., charts tables, 8.70 rm. This is a study of the theory of pulverized-coal combustion and of the conditions that affect its efficiency. The aerodynamics of dust, the combustion reaction, and heat transfer from the particles are considered. The effect of various factors upon combustion are discussed and calculated speeds compared with measured ones. Ignition and other factors are treated. The book is intended to assist the designer and stimulate research.

THEORY OF FUNCTIONS. By E. C. Titchmarsh. Second edition. Oxford University Press, New York, 1939. Cloth, 6 × 9 in., 445 pp., tables, $8.50. These introductory chapters to various branches of the theory of functions are intended to bridge the gap between the elementary textbooks and the systematic treatises. Chapter topics include infinite series, analytic functions, residues, analytic continuation, the maximum-modulus theorem, conformal representation, power series, infinite functions, differentiation, Lebesgue integration, and Dirichlet and Fourier series. There is a bibliography.

TRAINS, TRACKS, AND TRAVEL. By T. W. Van Metre. Simmons-Boardman Publishing Corporation, New York, 1939. Cloth, 7 × 10 in., 341 pp., illus., diagrams, tables, $3.50. This profusely illustrated book, by the professor of transportation at Columbia University, gives a readable, accurate account of present-day railroading. The descriptions of equipment and operating methods are clear, simple, and detailed. Although intended primarily for boys, the book will be useful to all amateurs of railroading. This edition has been revised and expanded, and entirely reset.

VAPOR CHARTS and Special Tables for Turbine Calculations. By F. O. Ellenwood and C. O. Mackey. John Wiley & Sons, New York, 1939. Cloth, 8 × 11 in., 43 pp., charts, tables, $2.50. These charts replace the "Steam Charts" published by Professor Ellenwood in 1914. The book form of chart is retained, but the steam tables have been greatly extended and improved. Charts that show the thermodynamic properties of water, ammonia, dichlorodifluoromethane (freon-12), and mixtures of air and water vapor have been added.

V.D.I.-Forschungsheft 396, May-June, 1939. MECHANISCHE FESTIGKEIT VON PHENOL-FORMALDEHYD-KUNSTSTOFFEN, by A. Thum and H.-R. Jacobi. V.D.I. Verlag, Berlin, 1939. Paper, 8 × 12 in., 39 pp., illus., diagrams, charts, tables, 5 rm. Methods for determining the mechanical strength of phenol-formaldehyde plastics under various conditions are described, including the use of steel-wire reinforcement. Results of tests and photoelastic examinations are given, and many photomicrographs of the internal structure of test pieces.

WALZWERKSWESEN, Vol. 3. (HANDBUCH DES EISENHÜTTENWESENS.) Edited by J. Puppe. Düsseldorf, Germany, Verlag Stahleisen; Julius Springer, Berlin, 1939. Cloth, 8 × 11 in., 669 pp., illus., diagrams, charts, tables, 96 rm. The first volume of this treatise on rolling-mill practice appeared in 1929, the second in 1934. The present volume completes the book, which is the most comprehensive work on the subject. The subjects covered in the present volume are the universal mill, plate and sheet mills, tube mills, the rolling of tires and wheels, and strip mills. Various specialists have assisted in the preparation of the text, which is admirably illustrated.

WAVE LENGTH TABLES WITH INTENSITIES IN ARC, SPARK, OR DISCHARGE TUBE of More Than 100,000 Spectrum Lines Most Strongly Emitted by the Atomic Elements Under Normal Conditions of Excitation Between 10,000 A and 2000 A Arranged in Order of Decreasing Wave Lengths. Measured and compiled under the direction of G. R. Harrison by staff members of the spectroscopy laboratory of the Massachusetts Institute of Technology, assisted by the Works Progress Administration. Technology Press, Cambridge, Mass.; John Wiley & Sons, New York, 1939. Cloth, 8 × 11 in., 429 pp., illus., tables, $15. The title of this book is sufficient description of its contents. The catalog is the most extensive that has yet appeared and will be of great value to all spectroscopic workers.

WINTER AIR CONDITIONING; FORCED WARM-AIR HEATING, edited by S. Konzo. National Warm Air Heating and Air Conditioning Association, Columbus, Ohio, 1939. Cloth, 6 × 9 in., 532 pp., illus., diagrams, charts, tables, $3. A large portion of this book is based upon the research work in forced-air heating that has been conducted in the Warm-Air Heating Research Residence at the University of Illinois since 1932. From this and supplementary data a comprehensive survey of the present status of the design, installation, and operation of the forced-air heating plant is gained. Extensive calculations, both theoretical and actual, are included for all phases of the subject.

DIE WIRTSCHAFTLICHE VERWENDUNG VON MEHRSPINDELAUTOMATEN. (Werkstattbücher, Heft 71.) By H. Finkelnburg. Julius Springer, Berlin, 1939. Paper, 6 × 9 in., 56 pp., diagrams, charts, tables, 2 rm. This pamphlet gives a concise description of the various types of automatic lathes, the work to which they are adapted, and the methods of using them. The selection of a lathe and the calculation of output are also discussed. The book is practical and is intended for operators and foremen.

WOOD STRUCTURAL DESIGN DATA, Vol. 1, also Supplements 1–5. Second edition. Edited by National Lumber Manufacturers Association, 1337 Connecticut Ave., Washington, D. C., 1939. Paper, loose leaf, 8 × 11 in. 296 pp., diagrams, charts, tables, $1; with supplements, $1.25. This handbook is intended to supply engineers and architects with accurate information on the physical, chemical, and mechanical properties of wood and with the data required for its safe, economical use in construction. This edition has been revised and enlarged. The data given have been drawn from the publications of the Forest Products Laboratory and from standard authors on the mechanics of materials.

# A.S.M.E. NEWS

*And Notes on Other Engineering Activities*

## Philadelphia Welcomes A.S.M.E. for Annual Meeting, Dec. 4–8

### Committee Functions, 35 Technical Sessions, Business Meeting, Photo Exhibit, Smoker, Banquet, and Inspection Trips

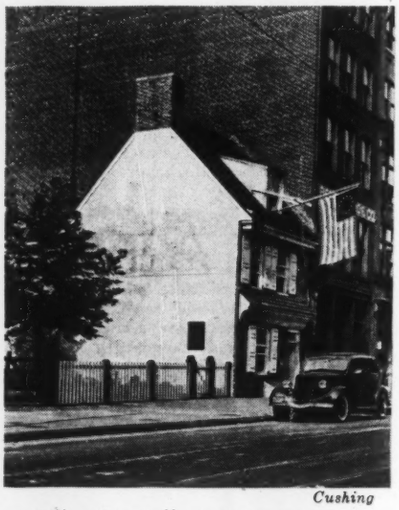
PHILADELPHIA, the "city of brotherly love," will be host to members and guests of The American Society of Mechanical Engineers, which is holding its Sixtieth Annual Meeting there, Dec. 4–8, the first time since 1890 that this annual affair has been held outside of New York City. Headquarters for the meeting and the scene for all technical sessions, smoker, business meeting, luncheons, and banquet, will be The Bellevue-Stratford Hotel, Broad and Walnut Streets.

#### Philadelphia, an Industrial City

It is a long, long time since a national meeting of the Society took place in Philadelphia; the last one was held there in 1887. During the last 52 years, the city has grown to such an extent that today it is one of the great industrial metropolises of the world, holding first place in the United States in the manufacture of textiles, steel, ships, radios, trolley cars, and many other products. It has been estimated that in an average year approximately $2,000,000,000 worth of goods are produced here. Included among the many large plants, some of which will be visited during the five-day meeting, are the Baldwin Locomotive Works, largest in the world, William Sellers & Co., RCA Manufacturing Co. (Camden, N. J.), SKF Industries, Westinghouse Electric & Manufacturing Co. (turbines), Philadelphia Electric Co., Henry Disston & Sons (saws), Pennsylvania Sugar Co., Philco Radio & Television Corp., U. S. Mint, John Bromley & Sons (lace and rugs), Cuneo Press, Curtis Publishing Co., Philadelphia *Inquirer*, League Island Navy Yard, Frankford Arsenal, J. G. Brill Co., Link Belt Co., E. G. Budd Co. (builders of streamlined trains), Beck Printing Co., Richmond Generating Station, Schuylkill Generating Station, Ford Motor Company, Philadelphia Gear Works, Pennsylvania Forge Co., General Electric Co., Stetson Hat Co., and one of several oil refineries.

#### All-Day Inspection Trip

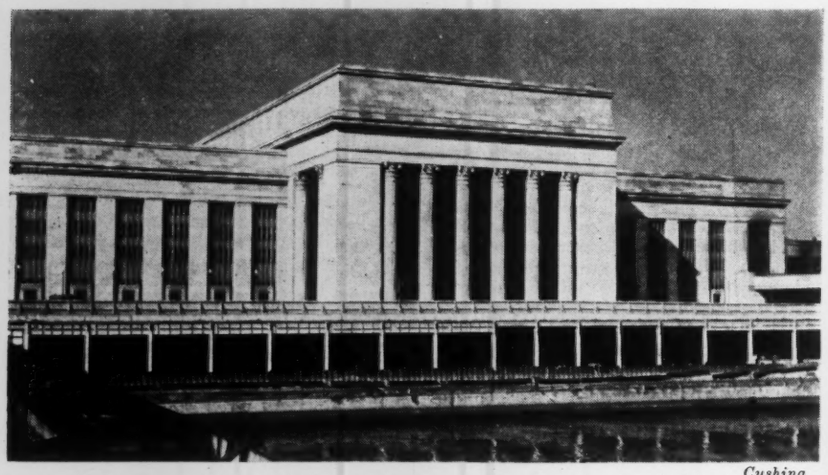
The Plant Trips Committee is planning an all-day inspection trip to hydropower plants at Conowingo, Md., Holtwood and Safe Harbor, Pa., on Thursday, Dec. 7, especially for hydraulic engineers. The Conowingo hydroelectric plant, located 65 miles from Philadelphia near the mouth of the Susquehanna River, has a rated capacity of 338,000 hp. Additional installations will bring this figure up to 531,000 hp. About 30 miles up the river is the Holtwood plant, which is a combined hydroelectric and steam-electric power development consisting of a 150,000-hp hydroplant and a pulverized-coal-burning steam plant with an initial capacity of 30,000 hp and an ultimate capacity of 200,000 hp. Eight miles further up the river is the Safe Harbor hydroplant with a rated capacity of 255,000 hp and a future capacity of 510,000 hp.



*Cushing*

THE "BETSY ROSS" HOUSE, PHILADELPHIA

(The famous little house in Arch Street where Mrs. Ross in 1777 sewed the thirteen-star flag—our first stars and stripes. Note the thirteen-star flag flying from the house.)



*Cushing*

THE NEW PENNSYLVANIA RAILWAY STATION IN PHILADELPHIA

#### Educational and Scientific Institutions

Philadelphia is also an educational and scientific center, having such institutions as the University of Pennsylvania (founded by Benjamin Franklin in 1740), Temple University, St. Joseph's College, Girard College, La Salle College, Drexel Institute of Technology, Curtis Institute of Music, Wagner Free Institute of Science, Franklin Institute, Fels Planetarium, Swarthmore College, Villanova University, and the Commercial Museum.

#### Technical Sessions

According to a tentative program outlined, there will be 35 technical sessions at which 105 papers on all phases of mechanical engineering will be presented. In order to accommodate those members who cannot come to the sessions in the daytime, five simultaneous technical sessions, covering the subjects of work standardization, machine-shop practice, aeronautics, elasticity, and fuels, will be held on Monday evening, Dec. 4. Another revived feature of Annual Meetings, which should draw a capacity crowd, is the get-together

*Cushing*

THE SKYLINE OF THE DOWNTOWN BUSINESS SECTION OF PHILADELPHIA

(Viewed down the parkway, centering on City Hall, with the camera planted on the steps of the Art Museum.)

smoker on Tuesday evening. The conferring of honors is to be made during the Annual Dinner on Wednesday, Dec. 6. As usual, college reunions of mechanical engineers will be held on Thursday night. The fourth annual A.S.M.E. Photographic Exhibit will be on view all during the week of the meeting.

### Tentative Program

A brief outline of the tentative program for the 60th Annual Meeting follows:

#### Monday, Dec. 4

*Morning*

Council meeting
Local Sections' delegates meeting
Professional Divisions' delegates meeting

*Afternoon*

Business Meeting
Public hearing on dust-separators code

*Evening*

Management—work standardization
Machine shop practice—motion economy
Aeronautics
Elasticity
Fuels I

#### Tuesday, Dec. 5

*Morning*

Photoelasticity
Fuels II
Management—scientific analysis
Iron and steel
Prime-mover regulation I
Machine design

*Noon*

S.P.E.E. luncheon
Machine design luncheon

*Afternoon*

Power—panel discussion
Dynamics
Fuels III
Graphic Arts
Management—industrial marketing

*Evening*

Get-together smoker
Nominating Committee report

#### Wednesday, Dec. 6

*Morning*

Education and training
Prime-mover regulation II
Rubber and plastics
Lubrication I
Textiles I
Heat transfer

*Noon*

Textile luncheon
Student members' luncheon

*Afternoon*

System regulation
Rubber and plastics creep
Textiles II
Lubrication II
Management—administrative organization

*Evening*

Annual Dinner
Conferring of Honors

#### Thursday, Dec. 7

*Morning*

Symposium on piping design
Industrial instruments
Railroad
Mechanical springs
Thermodynamics

*Noon*

Annual Meeting luncheon

*Afternoon*

Power—turbine blading
Materials handling
Steam generators

*Evening*

College reunions

#### Friday, Dec. 8

*Morning and afternoon*

Council meeting

## *Official Notice*

## A.S.M.E. Business Meeting

THE Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held Monday afternoon, December 4, at 2:00 p.m. in Room 115 of the Bellevue-Stratford Hotel, Philadelphia, Pa., as a part of the Annual Meeting of the Society.

The Annual Report of the Council and other Committee reports will be presented for the action of the members. There will be an opportunity also for members desiring to do so to bring any other business before this meeting.

(*Signed*) C. E. DAVIES
*Secretary*

## Fourth Annual A.S.M.E. Photographic Exhibit Philadelphia, Dec., 1939

MEMBERS of the Society and their friends are invited to submit technical and nontechnical photographs for showing at the Fourth Annual A.S.M.E. Photographic Exhibit to be held during the 1939 Annual Meeting of the Society in Philadelphia, Dec. 4–8, 1939. Prints mounted on 16 × 20-in. light-colored cards should be sent, on or before Nov. 30, 1939, to the A.S.M.E. Photo Exhibit Committee, The Engineers Club, 1317 Spruce Street, Philadelphia, Pa., together with an entry fee of $1 to cover return postage, insurance, wrapping, etc. This year, MECHANICAL ENGINEERING will award cash prizes of $5, $3, and $2, and honorable-mention citations for all photographs selected for reproduction on the cover and in the editorial pages of the Society's journal. Official entry forms may be secured from the Committee.

# Boston Section to Be Host to A.S.M.E. Wood Industries Division, Oct. 12–13

## Program of Valuable Technical Papers Combined With Unusual Array of Inspection Trips Will Attract Many

AN INTERESTING program has been arranged to attract both members of the Society and their guests interested in the wood-industries field, to the twelfth national meeting of the A.S.M.E. Wood Industries Division in Boston, Mass., Oct. 12–13, with headquarters at the University Club.

The inspection trips scheduled on the program will be of interest not only to the men in attendance at the meeting but also to the women and they will be welcome guests. A special invitation is also extended to them to attend the dinner of the Division on Thursday evening.

Reservations for rooms should be mailed directly to the University Club at 40 Trinity Place, Boston. Single rooms are three and double rooms five dollars.

The detailed program of the meeting follows:

### THURSDAY, OCTOBER 12

**9:00 a.m. Registration, University Club**

**9:30 a.m. Technical Session**

The Economic Status of the Hardwood Dimension Industry, by Louis J. Bosse, managing director, Hardwood Dimension Manufacturing Assn., Louisville, Ky.

Development of Dimensional Control and Tolerances for Wood Products, by J. W. Medley, technologist, wood products, National Bureau of Standards, Washington, D. C.

Modern Timber Construction, by Conrad Pantke, Roof Structures, Inc., New York, N. Y.

**12:30 p.m.**

Sight-seeing trips around Boston

**6:30 p.m.**

Annual Banquet of the Wood Industries Division and Fall Meeting of the Boston Section, North Hall, Walker Memorial Building, Massachusetts Institute of Technology

Welcome: Prof. Edgar MacNaughton, chairman, Boston Section

Response: R. H. McCarthy, chairman, Wood Industries Division

Address: A Program for More Effective Cooperation Between the Woodworking Industries and the Education of Engineers, by Hugh P. Baker, President, Massachusetts State College

Technical Paper: A Plan of Foremanship Training, by Henry S. Jones, production engineer, Globe Wernicke Co., Cincinnati, Ohio

### FRIDAY, OCTOBER 13

**9:30 a.m. Technical Session**

Super-Pressed Plywood, by Thos. D. Perry, development engineer, Resinous Products and Chemical Co., Inc., Philadelphia, Pa.

Standardized Homes of Wood and Plywood, by John E. Burchard, director, A. F. Bemis Foundation, Massachusetts Institute of Technology

**12:30 p.m.**

Luncheon of Executive Committee of the Division, planning for 1940

**2:00 p.m.**

Inspection trips to local plants

#### Plants to Be Inspected

S. A. Woods Machine Company
New high-speed molders and matchers

Atlas Plywood Corporation
Shipping container laboratory and tests. New no-nail box container assembly

Simonds Saw & Steel Company
Unique windowless plant giving perfectly standardized working conditions for twenty-four hour operation

# 1940 A.S.M.E. Mechanical Catalog and Directory Out

## New Volume Contains More Than 500 Pages of Information

THE twenty-ninth annual A.S.M.E. Mechanical Catalog and Directory, 1940 edition, was published on October 1 by The American Society of Mechanical Engineers. Free distribution is now being made to members of the A.S.M.E.

According to the editors of the 1940 volume, it is the only book which covers the field of mechanical engineering so thoroughly. In its catalog section, manufacturers describe and illustrate their products that are of interest to mechanical engineers. This section is followed by a Directory which gives the user a practically complete and authoritative index to manufacturers of metals and alloys, power-plant equipment, power transmissions, instruments, materials-handling apparatus, aircraft power plants and instruments, foundry and machine-shop equipment, heating, ventilating, and air-conditioning machinery, electric motors and controls, equipment for process industries, pumps, fans, compressors, and many other types of mechanical apparatus. A page reference system in the Directory refers one to the catalogs for a description of the desired machine or equipment.

A 16-page insert listing all A.S.M.E. publications, such as American Standards, power test, construction, and safety codes, fluid meters, engineering biographies, bibliographies, research reports, and manuals, is included in this volume for the ready reference of A.S.M.E. members and other users.

# Machine Tool Congress and A.S.M.E. Session Canceled

THE Machine Tool Congress, together with the Machine Tool Show, which was to have been held at Cleveland, Ohio, Oct. 4–13, has been canceled. This also means the cancellation of the Oct. 5 session at the Congress being sponsored by the Machine Shop Practice Division of the A.S.M.E., at which President A. G. Christie was scheduled to preside and to present an address.

W. E. Whipp, president of the National Machine Tool Builders' Association, which was arranging the Congress, in making the announcement calling off the Congress, said: "The members of the Association feel that the greatest contribution the industry can make to the welfare of the nation at this time is to concentrate their entire efforts on the production of the greatest possible number of machine tools. Under the circumstances, the industry and its customers cannot afford the time of their keymen for a machine tool congress and show, and postponement is felt to be the wisest course."

# Petroleum Division to Hold Fluid Metering Conference

## With Oklahoma University in Norman, Nov. 2–4

FALL activity of the A.S.M.E. Petroleum Division will start with the joint Petroleum Fluid Metering Conference to be held in Norman, Okla., Nov. 2, 3, and 4, sponsored by the Petroleum Division of the A.S.M.E. and the College of Engineering, University of Oklahoma. The first conference, held in Norman, in the spring of 1938, was a great success.

### Papers and Discussions in Bulletin Form

The fall conference will be divided into five sessions. On Thursday morning, Nov. 2, the elements of fluid metering will be discussed, and in the afternoon the application of fluid meters to production problems. Friday morning's session will deal with pipe-line application of fluid meters and in the afternoon the session will cover the use of meters in refineries. Each session will be devoted to consideration of three papers with ample time allowed for discussions. On Saturday morning, Nov. 4, a round-table discussion of the general results of the four technical sessions will be held and the conference closed. It is believed that between 300 and 400 persons will attend this conference. Papers with full discussions will be later published in bulletin form.

While this conference will be devoted to the problems of the petroleum industry in measuring fluids, the results will be of more than passing interest to every other division of the A.S.M.E. because the measurements of fluids in some form is a general problem. As applied to the petroleum industry it is complicated because of the wide range of fluid mixtures handled by the different branches of this industry. If members of the A.S.M.E. are interested in securing copies of the bulletin

containing the papers and discussions, which will sell for $1.50 per copy, orders should be sent to the Mid-Continent office of the Petroleum Division, 211 Midco Building, Tulsa, Okla., promptly.

### Fill Out and Return Questionnaire

Work is being carried on to develop facts regarding the Petroleum Division, and members interested in its work can assist materially if they will fill in and mail to the Mid-Continent office the questionnaire sent out from New York City office some time ago. It is only by knowing the desires of the members that programs can be developed and work carried on satisfactorily.

## Maryland Enacts Registration Law for Professional Engineers

DURING the 1939 session of the Legislature of Maryland, an engineer's licensing law was passed and signed by Gov. Herbert R. O'Conor. To administer the act, a Maryland State Board for Registration of Professional Engineers and Land Surveyors was established. The Governor has appointed the following as members of the Board: A. G. Christie, President of the A.S.M.E.; John R. Baker, member A.S.M.E.; S. T. Powell, member A.S.M.E.; F. O. Schnure; and Vincent Cockey.

### A.S.M.E. Calendar

*of Coming Meetings*

**October 5–7, 1939**
Joint Meeting of A.S.M.E. Fuels and A.I.M.E. Coal Divisions, Columbus, Ohio

**October 12–13, 1939**
Wood Industries Division
Boston, Mass.

**November 2–4, 1939**
Joint Meeting with American Institute of Physics in a Symposium on Temperature Measurement, New York, N. Y.

**December 4–8, 1939**
Annual Meeting
Philadelphia, Pa.

**May 1–3, 1940**
Spring Meeting
Worcester, Mass.

**June 17–21, 1940**
Semi-Annual Meeting
Milwaukee, Wis.

**September 3–6, 1940**
Fall Meeting
Spokane, Wash.

*(For coming meetings of other organizations see page 22 of the advertising section of this issue)*

A PORTION OF THE COLUMBUS, OHIO, CIVIC CENTER, FROM THE DEPARTMENT OF STATE BUILDING

(The New Federal Building and Post Office is at left, City Hall in the center, while the towering AIU citadel rises at the right.)

# Recent Advances in Use of Bituminous and Anthracite Coal Subject of A.S.M.E.–A.I.M.E. Coal Meeting

## To Be Held in Columbus, Ohio, October 5–7

MANY recent advances in the use of bituminous and anthracite coal will be discussed at a joint meeting of The American Society of Mechanical Engineers and the American Institute of Mining and Metallurgical Engineers scheduled for Columbus, Ohio, October 5–7.

Mining methods, engineering service, new firing equipment, slag research, testing techniques, flame photography, steel melting, and the manufactured-gas industry are some of the subjects relating to the central theme of coal utilization on which well-known authorities will speak. The program, which was published in detail in the September issue, includes four technical sessions, the annual dinner, at which Dean A. S. Langsdorf of Washington University's engineering school will speak, and a morning of visits to manufacturing plants and industrial laboratories.

The opening session, Thursday morning, is a symposium on the effect of mining methods on coal characteristics. Thomas F. Downing, Jr., of the Philadelphia Electric Company; William C. McCulloch, of the United Electric Companies, DuQuoin, Illinois; and Prof. John W. Buch, of The Pennsylvania State College, will speak for the bituminous underground, bituminous strip, and anthracite underground mines, respectively.

### Engineering Aspects of Coal Utilization

Thursday afternoon the first of three papers will be given by T. R. Workman, fuel engineer of the West Virginia Coal and Coke Company, who will show how the coal producer attempts to follow through to the ultimate consumer with research and advice on the engineering aspects of coal utilization. R. L. Rowan, fuel engineer of the General Coal Company, Philadelphia, will discuss the need and possible form for an acceptance test for steam coal. Recent developments in anthracite firing equipment for commercial and industrial heating will be described by William Lloyd, of Combustion Engineering Corporation, New York.

On Friday morning, October 6, the use of pulverized coal as a fuel for open-hearth steel melting furnaces will be described by Joseph P. Kittredge, of the National Malleable and Steel Castings, Sharon, Pennsylvania. C. C. Russell, of The Koppers Company, Kearny, New Jersey, will present a new technique for measuring expansion pressures in the coking of coal, and A. M. Beebe, of the Rochester Gas and Electric Company, Rochester, New York, will discuss the future of manufactured gas and the interdependence of the gas and coal industries in supplying the public demands for energy in the form of gas.

### Research on Coal-Ash Slags

The concluding technical session, on Friday afternoon, features research on coal-ash slags and the use of photography in flame and combustion studies. P. Nicholls and W. T. Reid of the Pittsburgh Experiment Station of the Bureau of Mines will describe equipment developed for measuring slag viscosity and

present data on a wide variety of slags. A. A. Markson and W. H. Dargan, of the Consolidated Edison Company's research department, will describe their methods of furnace photography, showing motion pictures and slides, both black-and-white and in color.

Dean C. E. MacQuigg of the College of Engineering, The Ohio State University, will preside over the annual dinner on Thursday evening. Dean Langsdorf, guest speaker, has been asked to choose some sociological or economic phase of the coal industry as his topic. The program committee feels that an enjoyable, nontechnical, but worth-while occasion is assured by these arrangements.

### Inspection Trips

The Jeffrey Manufacturing Company has hospitably agreed to show visitors on Saturday morning its methods of manufacture and latest developments in mining and conveying machinery. Battelle Memorial Institute will welcome members of the group to its research laboratories, where investigations in fuels, metallurgy, ceramics, and chemistry are being carried on. Trips also are being arranged so that visitors may see the new water-cooled underfeed stoker in the municipal light plant and pulverized-coal firing at Big Walnut and Pickway steam stations of the Columbus and Southern Ohio Electric Company, where recent additions have been made.

Saturday afternoon, October 7, a block of seats in the Ohio State stadium is being held for football-minded fuel engineers. The Bucks are playing the University of Missouri Tigers. Requests for reservations should be sent to Professor S. R. Beitler, department of engineering, The Ohio State University, who is chairman of the local committee on general arrangements for the joint meeting.

### Joint Committee

General chairman of the meeting is R. A. Sherman, heading a joint committee including H. O. Croft, H. F. Hebley, J. E. Tobey, and H. E. Nold. Local committee chairmen are S. R. Beitler, arrangements, E. R. Kaiser, registration, and R. L. Cox, inspection trips.

Reservations for hotel rooms should be sent promptly to the Deshler-Wallick Hotel, Columbus, where all technical sessions of the Joint Meeting and the luncheons and dinner will be held.

## Instrumentation Contest Offers $500 in Prizes

THE second annual instrumentation contest with 12 prizes, totaling $500 and ranging from $200 as first prize, is announced by the Industrial Instrument Section of Scientific Apparatus Makers of America, 20 North Wacker Drive, Room 3014, Chicago, Ill. Two themes are specified: "Instruments Save Money" and "Instrumentation Makes Jobs." Each contestant is to submit either (*a*) an original report or (*b*) an original essay in support of either of the two themes. However, no manuscript should cover both themes. The contest closes Nov. 15, 1939, and the judging will be held promptly. Copies of the contest rules and official entry forms are available from the afore-mentioned address.

# British American Engineering Congress and 1939 Fall Meeting of A.S.M.E. in New York Canceled

JUST ten days before the scheduled opening of the British American Engineering Congress in New York, Sept. 4–8, which embodied the Fall Meeting of The American Society of Mechanical Engineers, held jointly with The Institution of Mechanical Engineers (Great Britain) and the Fall Meeting of the American Society of Civil Engineers being held jointly with The Institution of Civil Engineers (Great Britain) and the Engineering Institute of Canada, the following radiogram was received at A.S.M.E. headquarters:

LONDON—RECEIVED IN NEW YORK AUG. 25 1939
TO THE AMER SOC OF MECH ENGINEERS

INTERNATIONAL SITUATION AND OBLIGATIONS INDIVIDUAL MEMBERS COMPEL ABANDONMENT VISIT AMERICA STOP ANNOUNCEMENT CONVEYED WITH PROFOUND REGRET FROM PRESIDENT COUNCIL AND MEMBERS HOPING ANOTHER OPPORTUNITY FOR JOINT MEETING WILL ARISE

INSTITUTION OF MECHANICAL ENGINEERS

The American Society of Civil Engineers received a similar communication the same day from The Institution of Civil Engineers.

### All Plans and Arrangements Canceled

After conferences of the Council of the A.S.M.E., the Board of Direction of the A.S.C.E., and the officials of the Engineering Institute of Canada, it was decided, individually and jointly, to cancel all plans and arrangements for the Congress.

In answer to the radiogram, Prof. A. G. Christie, President of the A.S.M.E., sent the following letter to Mr. E. Bruce Ball, President of The Institution of Mechanical Engineers:

My dear Mr. Ball:

We received with deep regret the radiogram from your Institution announcing the abandonment of your visit to America. We are deeply disappointed not only because of the loss of a splendid opportunity to cement our professional friendship and to interchange ideas but also because international incidents have occurred which for the time being will stop normal progress and retard peaceful growth.

We hope that peace may be restored soon and that we may then have the honor of entertaining you in America.

Sincerely yours,
(signed) A. G. CHRISTIE
President, A.S.M.E.

Many of the arrangements for the Congress had been completed when the radiogram was received. These included reprints of all technical papers, a limited number of which are now available to members for the asking. Some of the functions which had to be scrapped included four technical sessions, the banquet at the Waldorf-Astoria and the nation-wide broadcast over N.B.C. of the addresses to be delivered that night, the various doings at the New York World's Fair, the celebration of the 75th anniversary of the founding of the School of Engineering at Columbia University, and the closing session in the Hall of Music at the World's Fair, which included the conferring of honorary memberships on distinguished engineers and the award of the I.M.E. James Watt International Medal to Henry Ford, member A.S.M.E. Other canceled events included the receptions planned for the visiting British engineers by the A.S.M.E. Local Sections in Boston, Washington, Detroit, and other cities.

### The Committees

Although the Congress did not take place as planned, much credit is due the members of the Society and Woman's Auxiliary for their hard work and efforts in behalf of the meeting. The idea for the Congress was initiated by the Standing Committee on Meetings and Program, R. F. Gagg, chairman, Erik Oberg, W. J. Wohlenberg, A. L. Kimball, N. E. Funk, H. G. Oliver, Jr., and G. L. Lingner. Directly responsible for the program was a General Committee, consisting of George L. Bourne, chairman, John Castlereagh Parker, vice-chairman and chairman of the New York Executive Committee, W. L. Abbott, R. W. Angus, W. L. Batt, Theodore Baumeister, Jr., A. T. Brown, Edwin S. Carman, C. W. E. Clarke, M. E. Cooley, F. H. Colvin, H. N. Davis, Alex Dow, J. M. Driscoll, W. F. Durand, Prescott Eddy, W. S. Finlay, Jr., R. E. Flanders, V. M. Frost, L. H. Fry, R. F. Gagg, John L. Harrington, R. E. W. Harrison, James H. Herron, A. J. Herschmann, Francis Hodgkinson, Jerome C. Hunsaker, Dugald C. Jackson, D. S. Jacobus, W. M. Keenan, D. S. Kimball, J. N. Landis, C. N. Lauer, J. H. Lawrence, J. M. Lessells, S. H. Libby, Edgar MacNaughton, Charles T. Main, Lionel S. Marks, K. L. Martin, R. B. McColl, W. W. Nichols, Geo. A. Orrok, G. B. Pegram, R. J. S. Pigott, A. A. Potter, Walter Rautenstrauch, George K. Saurwein, L. K. Sillcox, Robert A. Spencer, and Roy V. Wright. The Transportation and Special Events Committee was composed of Edward R. Lee, Jr., chairman, G. E. Brien, John F. Daggett, Martin Frisch, W. F. Haaren, Wm. Hardie, C. R. Leach, Jr., Frank M. LeCompte, R. P. Lockett, Ralph G. Macy, W. McC. McKee, George J. Nicastro, A. R. Smith, R. L. Townsend, and H. W. Wetjen. For the banquet and dance, Dean J. W. Barker was general chairman and G. L. Knight was chairman of the A.S.M.E. group of this committee which included Theodore Baumeister, Jr., C. W. Bryan, Jr., R. M. Gates, and Francis Hodgkinson.

### Women's Committees

Mrs. George W. Farny, who is president of the Woman's Auxiliary to the A.S.M.E., was general chairman of the Women's Committee of which the following women from the A.S.M.E. were vice-chairmen: Mrs. J. H. R. Arms, Mrs. E. C. Stahl, and Mrs. R. B. Purdy. Mrs. A. H. Morgan, was chairman of the Excursions Committee for the Women.

# Public Hearing on Proposed A.S.M.E. Test Code for Dust-Separating Apparatus

## Scheduled for Dec. 4, 1939, at Annual Meeting

WITH the increase in the rate of combustion in modern stoker-fired steam-generating units and the wide adoption of the pulverized-fuel method of firing, the necessity for removing the solid particles from the flue gas has increased. No standard or generally recognized method seemed to be available for determining the adequacy of dust-separating apparatus when installed in the power plant. Accordingly, after a discussion of this problem, the A.S.M.E. Power Test Codes Committee decided to appoint a new committee to be known as individual Committee No. 21, whose duty would be to draft a test code for dust-separating apparatus.

The individual committee, which has developed a code, consists of M. D. Engle, chairman, Ollison Craig, secretary, E. L. Anderson, A. D. Bailey, H. H. Bubar, W. G. Christy, H. O. Croft, J. M. DallaValle, Philip Drinker, J. W. Fehnel, H. F. Hagen, P. H. Hardie, C. W. Hedberg, J. H. Leech, H. E. Macomber, H. B. Meller, H. C. Murphy, and B. F. Tillson.

### Public Hearing During Annual Meeting

It is believed that in its present form this code meets the needs of all groups which from time to time have a part in the making of acceptance tests of this type of apparatus. However, the committee has decided to supplement its general distribution of tentative drafts of the code by a public hearing. This hearing has been scheduled for Monday, December 4, 1939, at 4:30 p.m. in the Bellevue-Stratford Hotel, Philadelphia, Pa., headquarters for the 1939 annual meeting. Complete copies of the proposed A.S.M.E. standard test code may be obtained from the Society's headquarters. All are cordially invited to attend this hearing whether or not they hold membership in the Society.

From any person who for one reason or another cannot attend the hearing, Committee No. 21, the main committee, and the Society will welcome suggestions for corrections or additions to this tentative draft. These communications should be addressed to the chairman of the committee, in care of The American Society of Mechanical Engineers, 29 West 39th Street, New York, N. Y.

The term "dust-separating apparatus" is intended to include all devices used for separating gas-borne solid particles from the medium in which they are carried. This code is designed to cover tests on all types of dust-separating apparatus installed for operation in conjunction with solid-fuel-fired furnaces. It may be applied to a much wider field, but is not applicable to devices used in cleaning air for ventilation. Some of the names that have been applied to dust separators are as follows: Collector, catcher, trap, filter, precipitator, eliminator, washer, scrubber, and cyclone.

### Object of Test

The object of the test is said to be to determine the performance characteristics of dust-separating apparatus. The code provides mandatory rules for determining the performance of the apparatus with regard to one or more of the following:

(*a*) The over-all efficiency of the separator.
(*b*) The efficiency of separation according to size of particle.
(*c*) The resistance to gas flow, i.e., the pressure loss in the separator.
(*d*) The dust concentration at the inlet and outlet of the separator.
(*e*) The size analysis of the dust entering, leaving, and caught by the separator.
(*f*) The combustible content of the dust entering, leaving, and caught by the separator.
(*g*) The quantity of gas passing through the separator.

### Three Methods Sanctioned

The scope of the code excludes the determination of the performance of full-size dust separators by the use of models, or from a single unit of multiple-unit separators. The convenience of this method of testing is overbalanced by the fact that the results are very likely not to be indicative of the full-size apparatus in actual service.

Three methods of determining the performance of dust-separating apparatus are sanctioned by this code. Any one or all may be used. However, the physical conditions encountered often make one or the other impractical or at least undesirable.

*Method A.* This method is based on the determination of the average dust concentration at the inlet to the separator and at the outlet of the separator. From these data the efficiency can be computed in accordance with the equations given in Section 5 of the code entitled "Computation of Results," which are based on the assumption that no change in the mass of gas flowing takes place between the two sampling locations. It is not necessary with this method to know the gas flow rate or total quantity passing through the separator for the duration of each run, nor is it necessary to weigh or sample the dust caught.

*Method B.* This method is based on the quantity of dust caught, the dust concentration at the outlet of the separator, and the total quantity of gas passing through the separator. Obviously, this method can be applied only to those installations where the dust can be removed from the hopper in the dry state for the period of each test run. It is necessary also to be able to measure the total quantity of gas passing through the separator with reasonable accuracy in order to correlate the average outlet dust concentration with the total quantity of dust caught. The method of computation is set forth in Section 5 "Computation of Results."

*Method C.* This method is based on the quantity of dust caught, the dust concentration at the inlet of the separator, and the total quantity of gas passing through the separator. The other factors relative to measurement by this method apply as in method *B*.

The A.S.M.E. Committee on Power Test Codes was organized by the Council of the Society in 1918 to revise and enlarge power test codes of the Society published in 1915. This committee consists of a main committee of twenty-five members under the chairmanship of Francis Hodgkinson and twenty-one individual committees of specialists who have drafted codes for the various prime movers and other auxiliary and related apparatus which constitute power-plant equipment.

# Civil Engineers Publish Wage Schedule and Grading Plan

A GRADING plan and compensation schedule for civil-engineering positions of the lower professional grades, including preprofessional, was unanimously adopted by the Board of Direction of the A.S.C.E., July 25, 1939, and published in the September, 1939, issue of *Civil Engineering*. In the foreword, attention is called to the fact that while the job specifications under the plan indicate a range for duty and responsibility in each grade, to be of general application of civil-engineering employment, these specifications would be used with liberal judgment as to application and adaptability to meet local situations and sectional divergences which naturally exist within a field national in extent. When so used, the report states, the specifications, examples, and compensation rates will adequately serve as a guide to establish the basic organization requirement as well as the applicable remuneration for the several grades.

Since the report is three printed pages in length, only the definition of each grade and its scale of wages is noted here. Those interested may obtain the requirements for education, experience, and skill from the original article, reprints of which are available from the A.S.C.E., 33 West 39th Street, New York, N. Y.

### Preprofessional Grade 0

*Definition:* To include all positions the duties of which involve the performance of work incident, subordinate, or preparatory to work performed by employees holding positions in the professional grades.

*Compensation:* Starting rate, $110 a month, $1320 a year. Full rate, $165 a month, $1980 a year. It is noted that the scale or range for Grade 0 has 10 intermediate rates, or 12 rates for the scale, separated by intervals or step-ups of $60 a year, or $5 a month.

### Professional Grade I

*Definition:* To include all positions the duties of which involve civil-engineering work of minor professional difficulty and responsibility.

*Compensation:* Starting rate, $170 a month, $2040 a year. Full rate, $210 a month, $2520 a year. It is noted that the scale or range for Grade I has three intermediate rates, or five rates for the scale, separated by intervals or step-ups of $120 a year, or $10 a month.

### Professional Grade II

*Definition:* To include all positions the duties

of which involve civil-engineering work of intermediate professional difficulty and responsibility.

*Compensation:* Starting rate, $220 a month, $2640 a year. Full rate, $270 a month, $3240 a year. It is noted that the scale or range for Grade II has four intermediate rates, or six rates for the scale, separated by intervals or step-ups of $120 a year, or $10 a month.

**Professional Grade III**

*Definition:* To include all positions the duties of which involve civil-engineering work of considerable professional difficulty and responsibility.

*Compensation:* Starting rate, $280 a month, $3360 a year. Full rate, $325 a month, $3900 a year. It is noted that the scale or range for Grade III has two intermediate rates, or four rates for the scale, separated by intervals or step-ups of $180 a year, or $15 a month.

## Connecticut Sections Honor Professor Scott on 75th Birthday

CHARLES F. SCOTT

THE meeting on Sept. 19, of all A.S.M.E. and A.I.E.E. Local Sections in Connecticut at the Lawn Club in New Haven was scheduled as a testimonial dinner for Prof. Charles F. Scott, 75 years old on that day. For the occasion, a testimonial was prepared for presentation at the dinner by Theodore H. Beard, chairman of the General Committee of the Connecticut A.S.M.E. Sections. A few excerpts from this testimonial follow:

"This testimonial comes from the heart of 500 of your fellow members of the six Connecticut Sections of the A.S.M.E. A testimonial is an appraisal; an analysis which gives reasons for the superior qualities attributed to its subject.

"First, Dr. Scott, we see you as a man, made up of chemical compounds having a net commercial value of less than one dollar, and as 'all men are created . . . equal,' that makes you not better than the rest of us poor mortals—chemically—so we must analyze further.

"Second, your worth as an engineer has been evaluated by products developed under your supervision and by a definite compensation from the Westinghouse Electric & Mfg. Co. As engineers, we question whether there could be an adequate monetary recognition for the man who, among his many achievements, was primarily responsible for the design and installation of the first alternating-current power system in America. . . .

"Third, how can the influence you have exerted on students at Yale, in your 22 years of service there, be measured? Frankly, we do not know. You have trained men who have become eminent engineers. You have trained men who have probably forgotten whether a Scott connection is an electrical hook-up or one of your relations, but not a man in your classes has forgotten Professor Scott. . . .

"Student branches of national engineering societies stand as another monument to your work. The Lamme Medal and honorary degrees recognize the distinguished service you have rendered in education and development of engineers. In spite of the opportunity for ease provided by a well-earned retirement, you are now giving untiring service to the Engineers' Council for Professional Development, The Society for the Promotion of Engineering Education, The National Council of State Boards of Engineering Examiners, the Connecticut Board of Registration for Professional Engineers and Land Surveyors, and similar organizations. . . .

"And now on this, your 75th anniversary, dear Dr. Scott, we engineers greet you. We earnestly hope your active participation in the work of our profession may continue for many years. Our testimonial consists of many words some of which may be forgotten but two words will be fixed in the memory of thousands of engineers—Great Scott!!!"

## Detroit Section Outlines Complete Program for 1939–1940

DETROIT section has a complete program setup for 1939–1940. Eight sessions are scheduled as follows: Oct. 3, "Advanced Sheet Metal Stamping," by Wm. Longfield, followed by an inspection of the Ford press plant; Nov. 14, "Turbine-Electric Locomotive," by C. M. Davis; Dec. 12, "Hydraulic Couplings," by G. J. Scranton, R. M. Nelden, and F. A. Jennings, under the sponsorship of the Junior Group; Jan. 12, "Sampling Public Opinion," by Henry G. Weaver, followed by an inspection of the Hiram-Walker Distillery in Windsor, Ontario, Canada; Feb. 6, "Storing and Handling Coal," by G. C. Daniels and H. L. Parr; March 5, "Domestic Power Plants," by various speakers; April 2, "Detroit's Sewage Disposal System," by various speakers, followed by an inspection of the city's new sewage-treatment plant; and May 7, "1941 Automotive Engineering," by C. F. Kettering, followed by an inspection of the G.M. Proving Grounds.

## Color Photography Meeting Held by Los Angeles Section

PRECEDED by a dinner, the September meeting of the Los Angeles Section, A.S.M.E., was held the second Thursday of the month, Sept. 14, at the Marie Louise Tea Room in the Barker Bros. Building. The topic of the evening was color photography. The first paper, by Dr. Thomas S. Curtis, discussed "Engineering Phases of Color Photography" and gave a demonstration of the various devices and equipment used on color cameras. "Color Photography in the Motion Picture Industry," by Carroll H. Dunning, was the title of the second paper.

## Cleveland Section to Hear T. M. Girdler on Sept. 26

ACCORDING to an announcement from the Cleveland Section, A.S.M.E., the first meeting of the 1939–1940 season of the Section will be in the form of a joint meeting, sponsored by the local groups of the A.S.C.E., A.S.M.E., A.I.E.E., and the A.I.M.E., at the Cleveland Public Auditorium, Sept. 26. Frank C. Tolles, chairman of the Cleveland chapter of the A.S.C.E., will preside and present the other engineering group chairmen, G. B. Carson, A.S.M.E., H. J. Dible, A.I.E.E., and M. D. Harbaugh, A.I.M.E. Following this, Donald B. Gillies, national president of the A.I.M.E., will introduce the speaker of the evening, T. M. Girdler, chairman of the board of the Republic Steel Corporation.

## Metropolitan Section Is Scheduling 176 Sessions for 1939–1940

UNDER the chairmanship of Dr. Frank D. Carvin, the Program Committee of the Metropolitan Section, A.S.M.E., has scheduled 86 technical and 90 educational sessions for the 1939–1940 season. Because of the wide-range interests of the 3000 or more members in the Metropolitan area, the technical sessions will

## 1939 Local Sections Group Conferences

| Group | City | Place | Date | In charge of | Presiding officer |
|---|---|---|---|---|---|
| I | Boston | Hotel Statler | Nov. 4–5 | R. A. Spence | R. A. Spence, Boston |
| II | New York | A.S.M.E. Headquarters | Nov. 2 | T. B. Allardice | C. A. Hescheles, Metropolitan |
| III | Syracuse | Syracuse Univ. | Nov. 4–5 | M. F. Williams | J. T. Rea, Anthracite-Lehigh Valley |
| IV | Greenville | Poinsett Hotel | Oct. 28–29 | A. D. Asbury | N. C. Ebaugh, Florida |
| V | Columbus | Fort Hayes Hotel | Oct. 21–22 | W. A. Welcker, Jr. | C. J. Freund, Detroit |
| VI | Chicago | Palmer House | Oct. 28–29 | L. M. Ellison | R. E. Turner, Chicago |
| VII | Salt Lake City | Newhouse Hotel | Oct. 28–29 | H. M. Ferguson | S. F. Duncan, Los Angeles |

include such subjects as applied mechanics, hydraulics, heat transfer, fuels, steam power, oil and gas power, railroads, aeronautics, automotive, vertical transportation, marine, machine-shop practice, process industries, sanitation, iron and steel, petroleum, materials handling, graphic arts, textiles, woodworking, welding, management, time and motion study, national defense, junior functions, forum discussions, photography, and German. During October, one or more sessions are being held every day of the month at A.S.M.E. headquarters, Engineering Societies Building, 29 W. 39th Street, except on Saturdays, Sundays, Columbus Day, and October 27.

## Preliminary Schedule of San Francisco Section Meetings

THE following is a tentative preliminary schedule of the meetings planned by the San Francisco Section, A.S.M.E., for the year 1939–1940: Oct. 28, aircraft; Dec. 7, national defense; Jan. 18, President's meeting; Feb. 29, ladies' night; March 28, joint meeting with other Founder Societies; April 5, materials; and May 23, power.

## Metropolitan Section Starts Autumn Review Courses

MEMBERS of the A.S.M.E., A.I.E.E., A.S.C.E., A.I.M.E., may enroll in one or more of the autumn review courses being given again this year under the sponsorship of the Metropolitan Section, A.S.M.E., and the Power Group, N. Y. Section, A.I.E.E. in the Engineering Societies Building. Subjects include structural planning and design, engineering economics and practice, basic engineering sciences, mechanical engineering, electrical engineering, and public speaking. Except for the last subject, fees are $10 for members and $20 for nonmembers. The fee for the last course is $15 for members and $20 for nonmembers. Instructors include S. W. Spielvogel, G. W. Barnwell, R. C. Scafe, C. A. Hescheles, and G. J. Nicastro.

## Lehigh University to Hold Air Conditioning Conference, Nov. 10–11

THE program for the Eastern Air Conditioning Conference at Lehigh University, scheduled for Nov. 10 and 11, is almost completed, according to Prof. B. H. Jennings, member A.S.M.E., and chairman of the Conference. This meeting has been arranged in cooperation with the A.S.R.E., the Philadelphia chapter of the A.S.H.V.E., and the Air Conditioning Manufacturers' Association.

Plans call for sessions on industrial air conditioning covering such subjects as air conditioning in printing processes, in film manufacturing, cellophane and rayon manufacturing, fur storage and tobacco plants, and the removal of moisture from blast-furnace air, an interesting new application.

# Junior Group Activities

## Metropolitan Juniors Present Problems of Young College Man in Industry at Rutgers Conference

### Two-Hour Panel Discussion Covers Topics of Adjustments, Salaries, Company Policies, Superiors, and Job Problems

JUNIOR engineers have much to offer to their employers was the consensus of opinion of the members of the panel which discussed the problems of the young college graduate at the 14th Annual Industrial Conference of Rutgers University, New Brunswick, N. J., Sept. 7, 1939, held in cooperation with the Metropolitan Junior Group, A.S.M.E., and the Northern New Jersey Chapter, S.A.M. Members of the panel consisted of William H. Bedell, Frank Ferry, H. G. Oliver, Jr., O. B. Schier, II, George L. Williamson, and Leslie F. Zsuffa, chairman, the last four being Juniors of the A.S.M.E.

In opening the two-hour panel discussion, it was noted that the last two conferences included discussions by executives and personnel directors of what was wrong with the young college graduates; this year's panel of young men was going to show the faults of industry in its relations with young college graduates. Basing its opinions and statements on the answers to a questionnaire sent out to a group of young engineers and executives, the panel covered such points as adjustment into industry, adequacy of college education, salaries, cadet courses, company policies, superiors, and advertising oneself.

#### Going Into Industry

According to the panel, all young engineers experience a feeling of strangeness upon entering industry from college. The general impression seems that one changes abruptly from an individual to a member of a group. In many cases, graduates found their training sufficient for the first jobs but insufficient for later ones. Many corrected this deficiency by taking graduate courses in night schools or in correspondence schools. Some companies themselves arrange for their Junior engineers to take the necessary courses during business hours. In a comment from the floor, a young man stated that at no time in his four years of undergraduate work and two years of graduate studies was any mention made of how to understand human beings.

#### Salaries

Throughout the depression, Juniors did not expect much in the way of remuneration but in the last three years they expect more than they are receiving because of increased living costs. One member of the panel read a report of the A.S.C.E. which gave a wage schedule for young civil engineers (see page 767). It was also brought out that in some instances young men were fired when they asked for an increase, and in many companies it was necessary to ask for an increase in order to get it. The panel suggested that salary increases be based on periodic check-ups of a young man's work. However, very few companies have any sort of follow-up or check-up of a man's work.

#### Cadet Courses

At previous conferences, it was stated that men enrolled in the cadet courses of large companies do not earn their salaries because they are still learning. In the answers received by the panel to its questionnaire, many young men felt that they earned all they got while on cadet courses. On the whole, cadets who finished their courses thought they were very valuable. A major complaint of some men was the fact that little if any attention is paid by department heads to the cadets assigned to them. Consequently, the men get only a superficial glance into that department's workings. This has not received the attention of major executives because the cadets do not wish to report the facts because of the possibility of being assigned to work under the particular department head at a later date. It was suggested that the department head might delegate one of his men to supervise and orientate the cadets.

#### Superiors and Associates

Much of a man's early progress in industry depends on his superior or "boss," claimed the panel members. They defined a "good" boss as one who makes his subordinates feel at home, creates a friendly atmosphere about himself, and is ready to assist his men even after they are transferred to another department or company. The "bad" boss may have one or more of the following faults: Resentful of a man's college training, secretive, afraid of losing his job to a subordinate, treating subordinates as children, too helpful, causing man to lose initiative, maladjusted, unreasonable, and demanding that every action of his subordinates be approved by himself. An executive should make his men feel that they are doing a vital job, praise their work, and give constructive criticism.

#### Advertising Oneself

The perennial fault of engineers in failing to

take proper credit for their work was commented on. It was suggested that young engineers advertise themselves by preparing papers with the assistance of their superiors and others in his company for presentation before technical and engineering societies. This would call attention to them in the company as well as outside and help them to advance. According to one member of the panel, selling oneself is "salesmanship in reverse."

### Analyzing Oneself

However, everything does not depend on a man's company or superiors; much depends on himself contended the panel. A man should not be a 9-to-5 worker but should strive to improve his mind as well as his training after hours by taking courses, reading books, and attending the technical sessions of engineering societies. Industry today is not only looking for administrative engineers but also for good machine designers, production engineers, and sales engineers. According to the young men who are married, marriage does not dull independence and initiative. However, it was stated that some companies take advantage of a man's married status by not giving him the same number of increases as before because he is more dependent on his job.

### Conclusion

In summarizing the panel discussion at the evening session, Howard Lee Davis, vocational adviser of Brooklyn Poly., concluded by asking young engineers to study themselves, their development, and their work, and by requesting "bosses" to have a heart, but not too big a one, and to be kind, considerate, firm, and helpful. He was followed by the main speaker of the evening, Dr. Harvey N. Davis, past-president A.S.M.E., who outlined the requirements for a young engineer to achieve success in his chosen vocation. The printed proceedings of the conference will be available in the near future and may be secured by A.S.M.E. members upon a written request to Leslie F. Zsuffa, A.S.M.E. headquarters, 29 W. 39th St., New York City.

## San Francisco Juniors Hold Summer Meeting and Picnic

THE San Francisco Junior Group arranged a meeting on Aug. 17, at the Engineers' Club. Sam Dows, member A.S.M.E., and chairman of the San Francisco Engineering Council, presented a talk on the "Trend of Instruments in the Process Industries." He discussed various installations and the purposes of the instruments, and then described the operation of the differential type of flowmeter and its mechanics.

On July 23, the Junior Group took a day off to travel across San Francisco Bay and on into Marin County to Deer Park, at the base of Mount Tamalpais, where a real old-fashioned picnic was thoroughly enjoyed. Baseball and hiking were enthusiastically indulged in. This midsummer picnic was so successful that consideration is now being given to an enlarged recreational program for the members.

## Kansas City Juniors Have Meeting, Inspection Trip

ON Aug. 8, 1939, the Kansas City Junior Group held its regular monthly meeting in the K.C.P.&L. Co. Building. First speaker was Raymond Hahn, former Group chairman, who described some of his experiences at the New York World's Fair. Next on the program, Harold Manuel, present chairman of the Group, proceeded to give a description of the air-conditioning equipment used in the building in which the meeting was taking place. Following the talks, an inspection was made of the system. There were 14 members present.

# With the Student Branches

## Student Members Numbering 1850 Attend Ten Group Meetings and Present 132 Papers

THE most successful year in A.S.M.E. Student Branch history was concluded in June, 1939, with a total membership of 6061 in 117 schools and universities, and an attendance of 1850 student members at ten Student Group Meetings at which 132 papers were presented in competition for cash prizes amounting to more than $1000. Following the meetings, several of the contestants used their papers in obtaining positions, fellowships, and scholarships; two A.S.M.E. student members, Richard H. Burroughs, Princeton, and Emil Kissel, C.C.N.Y., winning Boeing flying scholarships, each worth $1260.

During 1939–1940, it is expected that more student members will prepare and present papers at branch meetings and also at the Group Meetings. According to a tentative schedule released by the Committee on Relations With Colleges, the 1940 Student Group, Meetings will take place as follows: I, Worcester Polytechnic Institute, Worcester, Mass., May 3–4; II, Newark College of Engineering, Newark, N. J., Apr. 22–23; III, University of Maryland, College Park, Md., Apr. 29–30; IV, Birmingham, Ala., Apr. 8–9; V, Armour Institute of Technology, Chicago, Ill., Apr. 15–16; VI, University of Kansas, Lawrence, Kan., Apr. 19–20; VII, Texas Technological College, Lubbock, Tex.; VIII, State College of Washington and University of Idaho, Pullman, Wash., and Moscow, Idaho, Apr. 15–16; IX, University of New Mexico, Albuquerque, N. M.; and X, University of Santa Clara, Santa Clara, Calif. Dates for Groups VII, IX, and X are not yet set.

## Newark Branch Aims for Banner Year in 1939–40

ITS biggest year in both membership and activity is the 1939–1940 aim of the A.S.M.E. Student Branch at Newark College of Engineering. Membership is open to sophomore, junior, and senior mechanical students at the college. It is expected that the membership for this coming year will eclipse the all-time record of 114. A series of "get-acquainted" posters placed on the bulletin boards

AT THE 1939 PACIFIC NORTHWEST GROUP MEETING OF A.S.M.E. STUDENT BRANCHES, CORVALLIS, ORE., APRIL 2–4

# A.S.M.E. Student Group Meetings, 1939

### GROUP I—NEW ENGLAND STUDENT MEETING, ITHACA, N. Y., APRIL 14–15

Attendance: 129 Papers presented: 12

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | R. H. Stockard | Augmented Vacuum Lift on Airplane Wings | Rhode Island State |
| Second | R. J. Donohoe | Application of Dimensional Analysis to Cooling Towers | M.I.T. |
| Third | Thomas Verrill | Automatic Banking Device for Automobiles | Maine |
| Old Guard | A. L. Brown | The Linkage in a Tinned Steelcase Gas Meter | Brown |

### GROUP II—EASTERN STUDENT MEETING, PRINCETON, N. J., APRIL 24–25

Attendance: 284 Papers presented: 14

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | R. H. Burroughs, Jr. | Stabilator for Longitudinal Stability and Control of Aircraft | Princeton |
| Second | W. H. Bacha | Centerless Grinding | Virginia |
| Third | Vincent McK. White | The Great Republic | Lehigh |
| Old Guard | George Woodger | Low Weight and High Power | Pratt |

### GROUP III—ALLEGHENIES STUDENT MEETING, CLEVELAND, O., APRIL 30–MAY 2

Attendance: 260 Papers presented: 10

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | A. D. Smith | Cavitation | Toronto |
| Second | R. C. Juvinall | Effect of Ignition Adjustments on Automotive Economy | Case |
| Third | R. A. Riester | Socializing Influence of Modern Inventions | Carnegie |
| Old Guard | Robert Gottlieb | Stratosphere Flying | Maryland |

### GROUP IV—SOUTHERN STUDENT MEETING, KNOXVILLE, TENN., APRIL 10–11

Attendance: 150 Papers presented: 12

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | K. P. Baum, Jr. | Heating and Air Currents in Greenhouses | Tennessee |
| Second | Wickliffe Hendry | A Hydraulic Motor | Kentucky |
| Third | D. E. Jahncke | Social Responsibility of the Engineer | Tulane |
| Fourth | J. B. Lasley | Hydraulic Transmissions in Automobiles | North Carolina State |
| Old Guard | G. W. Wells | Fatigue of Metal | Florida |
| Sixth | Chas. Van Overbeker | Steam Jet Refrigeration | Louisville |

### GROUP V—MIDWEST STUDENT MEETING, CHICAGO, ILL., APRIL 17–18

Attendance: 407 Papers presented: 16

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | R. P. Campbell | Low-Temperature Refrigeration | Illinois |
| Second | D. C. Harvey | The Cone Worm Gear | Purdue |
| Third | H. B. Meserve | Volatility Characteristics of Chicago Winter Gasolines | Northwestern |
| Old Guard | J. L. Chapman | Super Finish | Michigan |
| Fifth | Christian Reimuller | Electro-Magnetic Control | Lewis |
| Sixth | David T. James | Bells | Michigan State |
| Seventh | Thomas Howe | Strength Vs. Durability in Modern Gear Design | Marquette |
| Eighth | J. S. Kehrer | Study of Eye Movements During Inspection Work | Iowa |

### GROUP VI—NORTHERN STUDENT MEETING, ST. LOUIS, MO., MAY 5–6

Attendance: 130 Papers presented: 18

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | | | |
| Second | | | |
| Third | | | |
| Old Guard | | Details not available | |
| Fifth | | | |
| Sixth | | | |

### GROUP VII—SOUTHWEST STUDENT MEETING, DALLAS, TEXAS, MARCH 20–21

Attendance: 165 Papers presented: 16

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Rudolph Bodemuller | Smoke Density | Texas |
| Second | M. C. Green | Internal-Combustion Engine With a Floating Head | Texas Tech. |
| Third | J. D. Wisenbaker | Oil-Well Pressure Maintenance by Recycling of Natural Gas | Southern Methodist |
| Old Guard | K. W. McLoad | Automatic Electrical Transmission for Automobiles | Arkansas |
| Fifth | L. J. Powers | Design of an Electrical Engine Indicator | Texas Tech. |
| Sixth | R. B. Kilgore | The Treating of Cracked Gasoline by the Doctor Sweetening Process | Southern Methodist |

### GROUP VIII—PACIFIC NORTHWEST STUDENT MEETING, CORVALLIS, ORE., APRIL 2-3-4

Attendance: 125 Papers presented: 10

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | J. F. Crews | Heat Transfer to Boiling Refrigerants | Oregon State |
| Second | Paul Sherwood | Commercial Development of Unit Freezers | Washington |
| Third | E. H. Moore | Alignment Chart for Design of Gears by Dynamic Load Method | Oregon State |
| Old Guard | Arthur Kraus | Stresses in Gears | Washington State |

### GROUP IX—ROCKY MOUNTAIN STUDENT MEETING, DENVER, COLO., APRIL 20–21

Attendance: 120 Papers presented: 12

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | Bruce Wiesley | The Tin Can and Its Double Seam | Utah |
| Second | S. E. Reynolds | Study of Heat Losses From Typical Steam-Pipe Conduit | New Mexico |
| Third | F. G. Hatch | Industrial Mobilization | Utah |
| Fourth | B. R. Miller | Design and Operation of Platen and Cylinder Presses | New Mexico |
| Fifth | J. E. Fuller | Commencement | Colorado |
| Sixth | Joseph Keithley | Plastic Materials in Airplane Manufacture | Colorado State |
| Seventh | Charles Carpenter | Procedure of Photographing and Laying an Aerial Mosaic | Colorado |

### GROUP X—PACIFIC SOUTHWEST STUDENT MEETING, SAN FRANCISCO, CALIF., APRIL 3–4

Attendance: 100 Papers presented: 12

| *Prize* | *Recipient* | *Title of Paper* | *College* |
|---|---|---|---|
| First | A. R. Champion | Design and Construction of Sweep-Voltage Generator | California |
| Second | Melvin Tilley | Reclaiming Lubricating Oil From Air and Ammonia Compresses | Nevada |
| Third | Walter Nass | Electrical Timing for Racing Cars | U.S.C. |
| Fourth | J. S. Parker | New Method of Boring Mine Shafts | Stanford |
| Old Guard | W. P. LeDuc | Application of Acoustical Control | U.S.C. |

serve to familiarize the prospective member with the activities of the student branch by exhibiting some of the publicity the branch gained during the last year. Shortly before the first meeting each sophomore will receive a personal letter in which A.S.M.E. activities will be described.

Preliminary plans for a group inspection trip in the fall through a local industrial plant are already under way. The new student chairman, George Breur, will call the opening meeting early in October, when plans for the ensuing year will be explained more fully.

The Newark Branch has been fortunate in being chosen host for the 1940 Eastern Student Group Meeting. The program committee for the convention will be chosen later this fall. This group, and the publicity committee will share much of the work of preparing a well-organized program.

## Minnesota Branch to Have Membership Rally —and Beans!

MINNESOTA Branch is planning an intensive program for the coming year, including a membership rally, bean feed, inspection trips, and interesting technical meetings. The membership rally during the first week of school will feature talks by many faculty members and the giving away of souvenirs. A membership at least as large as the 125 of last year is sought.

## Columbia, Stevens, N.Y.U., and Others Offer Courses

OPPORTUNITIES for Juniors in the New York Metropolitan area to advance their training in the engineering and other sciences are offered in the courses to be given this fall by Columbia University, Stevens Institute of Technology, N.Y.U., Brooklyn Poly., Newark College of Engineering, and Rutgers University. Complete details about the courses may be obtained by writing to any of these schools.

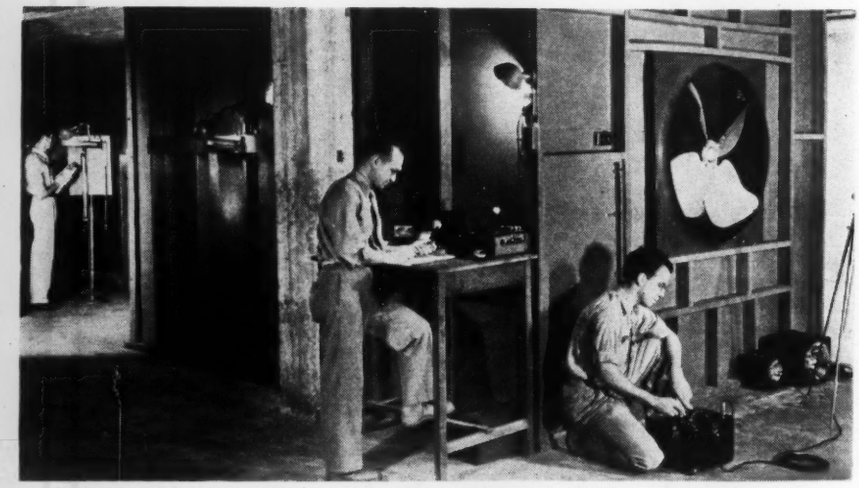
### Student Branch Secretaries

*Please Note!*

REPORTS of meetings and inspection trips must be received at Society Headquarters on or before the sixth of the month in order to appear in next month's issue of MECHANICAL ENGINEERING. Example: All copy received up to Oct. 6 will be in the November issue, etc.

PHOTOGRAPHS of student-member groups are always welcome for use in MECHANICAL ENGINEERING. Prints should be preferably glossy and of good contrast. However, send in everything you have and the editorial department will use those it can reproduce.

PUBLICITY is always good for the branch. Clippings from school and local newspapers should be sent in with your reports.



FAN-TESTING LABORATORY OF THE TEXAS ENGINEERING EXPERIMENT STATION, AGRICULTURAL AND MECHANICAL COLLEGE OF TEXAS; TEST STATION WITH ATTIC FAN INSTALLED FOR TESTING

## New York Engineers Assist in Work of Student Guidance

IN A report of the work done in 1938–1939 by the Student Guidance Committee of the Metropolitan Section, A.S.M.E., William H. Larkin, chairman of the committee, states that his committee's activities were coordinated with those of the New York Engineers Committee on Student Guidance, a group formed by the Founder Societies. The attached schedule of meetings shows 16 which were held at various high schools in the New York area and at which engineers gave talks on engineering careers. Then there were three meetings between the committee and the New York City Board of Education in order to help the latter body develop a program of student guidance. Mr. Larkin in conclusion says that it is expected that in 1939–1940 the number of meetings to be held in high schools will be more than doubled.

## A.S.M.E. Invited to the Inauguration of University of Texas President

THE inauguration of Dr. Homer Price Rainey, as president of The University of Texas will take place Saturday, Nov. 18, preceded on Thursday and Friday, Nov. 16 and 17, by conferences on outstanding educational problems. At the invitation of the regents and faculty of the University, the A.S.M.E. has designated E. W. Burbank, member of Council, to be its official representative.

## Texas A.&M. Gives Short Course in Air Conditioning

THE first annual short course in air conditioning was given by Texas A.&M. College under the sponsorship of the department of mechanical engineering, Aug. 17–19, 1939. There was a registration of 95. Papers on the subject were presented by H. E. Degler, F. E. Giesecke, A. M. Chase, R. A. Gonzalez, R. U. Berry, H. E. Shugars, W. E. Stark, John Howatt, and A. J. Rummel, many of whom are A.S.M.E. members.

## A.S.M.E. to Be Represented at Catholic Univ. Semicentennial

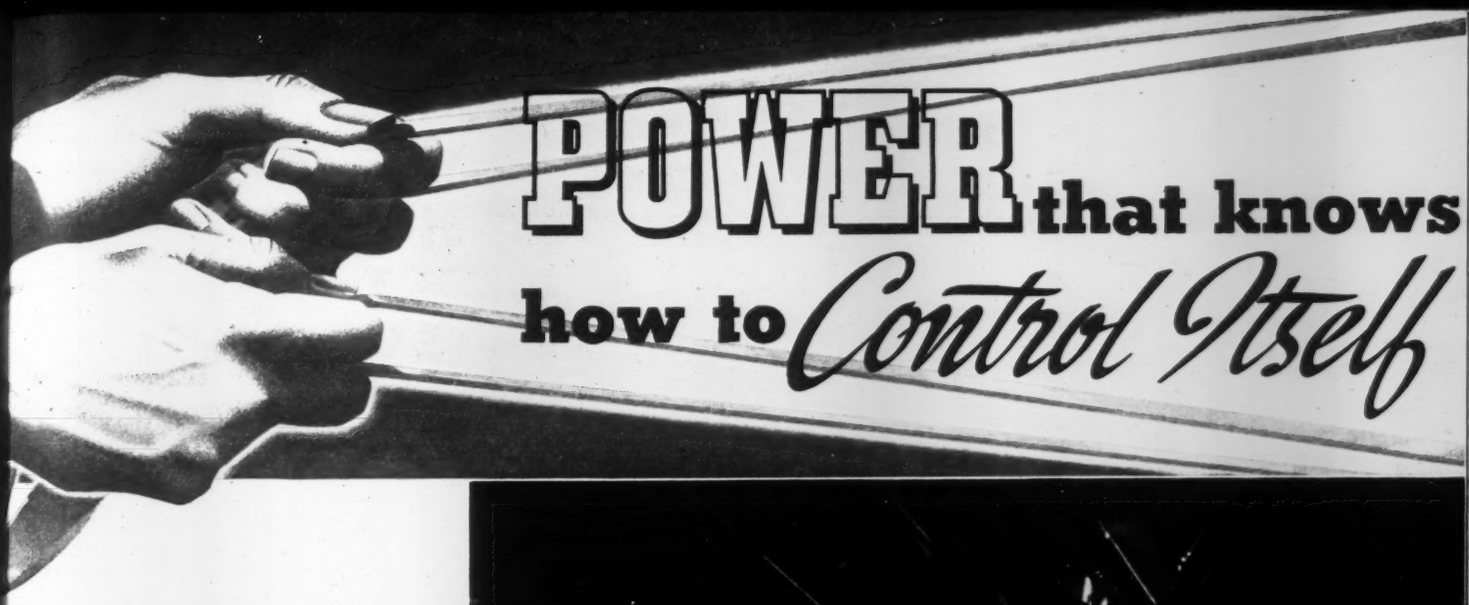
A.S.M.E. will be represented at the semicentennial of the founding of The Catholic University of America, Washington, D. C., Nov. 11–13, by Prof. A. G. Christie, President of the Society.

## The "Right" Mr. Morgan

THROUGH a regrettable error the photograph published last month over the caption "H. H. Morgan" was not the likeness of the newly installed president of the American Society for Testing Materials but of H. H. Morgan, who is associated with the Weller Manufacturing Company. With apologies to both Mr. Morgans we publish this month the photograph of the new A.S.T.M. president referred to in last month's news note on page 694.

H. H. MORGAN

(A.S.M.E. News continued on page 774)



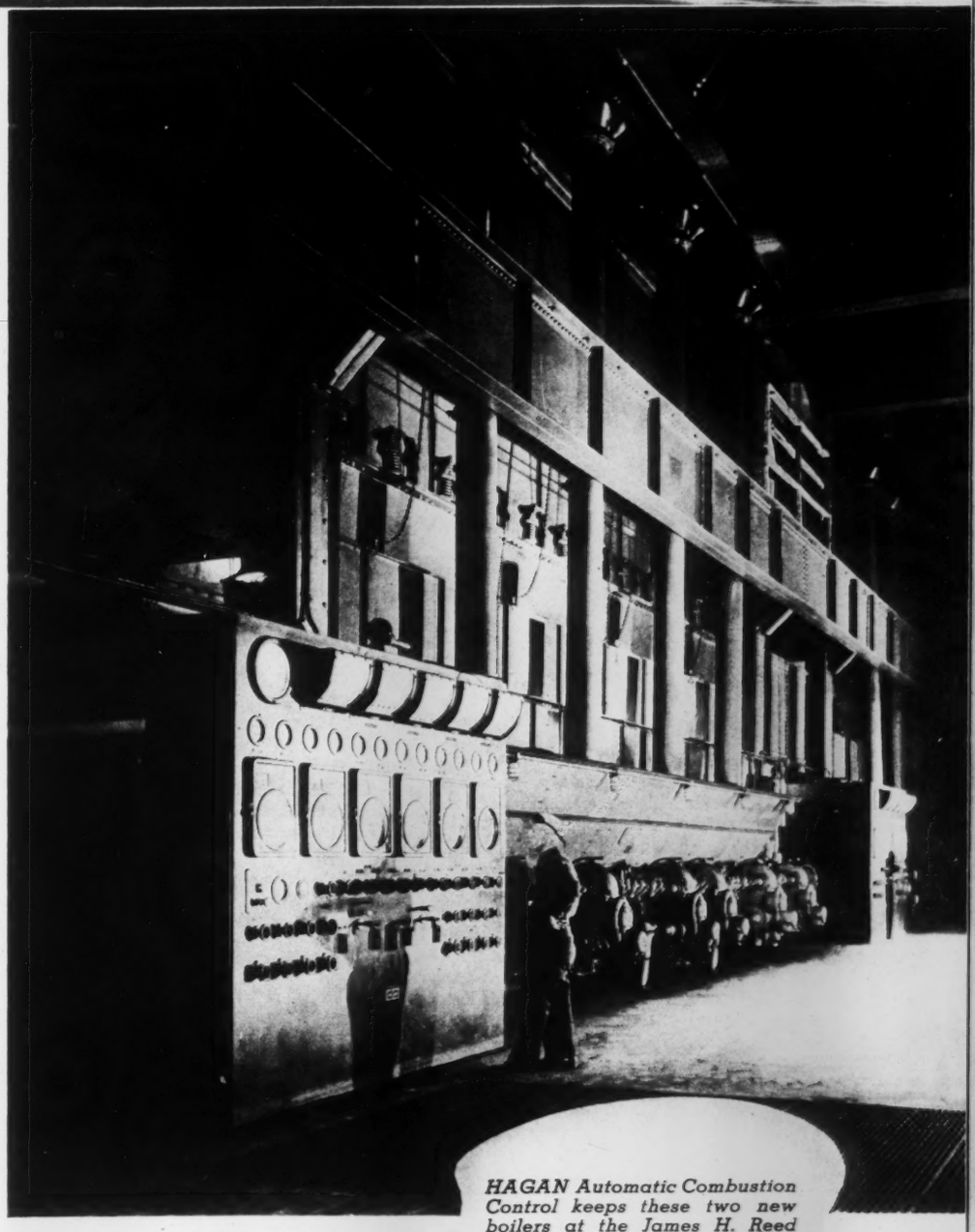
# POWER that knows how to *Control Itself*

THIS huge boiler plant could be operated from a rocking chair. It's that easy with Hagan Automatic Combustion Control. Panel and instruments merely show what's happening—the control equipment does the work.

When a sudden load is thrown on the system, Hagan Control instantly snaps into action, adjusts the fuel and air to produce more steam, and keeps the header pressure constant. All this happens in less time than it takes to tell it and without help from the operator. But Hagan Automatic Combustion Control goes even further — it includes superheat temperature control and zoned stoker control which keeps the fire bed uniform.

All these improvements increase overall plant efficiency and have played an important part in keeping the cost of steam and electricity low. Data are not yet available on savings in this plant through control, but based on recent experience in similar Hagan controlled plants, the equipment will easily pay for itself in less than two years. Think what this saving would mean on your coal bill.

The reliability and accuracy of Hagan Control have made it a favorite for all sizes of boilers and all types. Write for information. We have engineers capable of solving the toughest combustion problems.



***HAGAN** Automatic Combustion Control keeps these two new boilers at the James H. Reed Station of the Duquesne Light Co. operating at high efficiency under all load conditions.*

**HAGAN CORPORATION**

300 Ross Street • Pittsburgh, Pa.

**HAGAN *Automatic* COMBUSTION CONTROL**

*The pioneer . . . and still the leader*

# American Engineering Council

*Presents*

*The News From Washington and Elsewhere*

## War Preparednesss

THERE has been appointed recently a War Resources Board of six members, of which Dr. Karl T. Compton, member A.S.M.E., may be said to be the representative of science and engineering. Since this appointment, the Board has been working continuously, reviewing both the Army and Navy preparedness plans.

Experience from the Council of National Defense, headed by Walter S. Gifford, President of the American Telephone and Telegraph Company, in 1917, is available to the new Board through his membership. It is assumed that the War Industries' Board, now an advisory arm of the Army and Navy Munitions Board, in the event of war would become a War Resources Administration, reporting directly to the President. Presumably, it would attempt to coordinate the economy of the country with particular attention to the munitions requirements of the Army services and should war come, it would be assumed that these requirements for munitions would be coordinated with the needs of the civilian population.

Information at the office of the War Resources Board indicates that should a wartime industrial mobilization be necessary, it would revolve around the War Resources Administration, but that the actual administration of various activities would be in the hands of the regular agencies handling them or with new agencies.

One effective instrumentality developed in the twenty-two years that have passed since the last war are the trade and technical associations. Practically all the industries are highly organized and are in possession of statistical and other information which can be quickly put at the disposition of a War Resources Administration. In this connection, the annual meeting of the Army Ordnance Association is to be held October 11 and 12. On October 11, there is to be an industrial preparedness luncheon. In the afternoon there will be a round-table discussion of preparedness problems conducted by Gen. T. C. Harris, assistant chief of Ordnance. Benedict Crowell, president of the Army Ordnance Association, will preside at the dinner and Gen. George C. Marshall, the Chief of Staff, will be the dinner speaker.

# Men and Positions Available

*Engineering Societies Employment Service*

### MEN AVAILABLE[1]

COLLEGE GRADUATE, B.S., mechanical and electrical engineering, age 29. Eight years' experience steam power plants as operating and maintenance engineer. Desires position as chief or assistant chief engineer. Me-368.

MECHANICAL ENGINEER, 32, married, M.E. degree. Two years' production and development work, oil burners, valves, specialties. Previous 4 years special studies telephone plant. Present temporarily employed as valuation engineer. Available immediately. Me-369.

MECHANICAL AND STRUCTURAL ENGINEER with over 20 years' experience in chemical, copper, and rayon plant design, construction, maintenance, and research in the States and South America, seeks responsible position. Me-370.

GRADUATE MECHANICAL ENGINEER, age 49, with excellent machine- and boiler-shop experience, desires position as works or production manager. Capable of organizing, planning, and executing for economic production. Me-371.

GRADUATE MECHANICAL ENGINEER, 39. Broad experience in maintenance, steam power, and piping, general design specializing in piping, pressure vessels, heat exchangers, piping specialties, mild steel, and alloys. Now employed. Me-372.

MECHANICAL ENGINEERING GRADUATE, honor student, 1939 graduate, age 27. Has had considerable experience in constructing and testing carburetors of own design. Desires opportunity for advancement in research and testing. Me-373.

MECHANICAL ENGINEER, 33, married. Experience in domestic oil burners, gas engines, plant maintenance, assistant to steam engineer, and steam-boiler operation. Now employed as operating engineer. Me-374-396-D-6-San Francisco.

MECHANICAL ENGINEER with 15 years' experience in ball- and roller-bearing engineering and research, seeks position in similar industry. Has done considerable development and has many patents to his credit. Me-375.

MECHANICAL GRADUATE, 27. Three years' steam and hydraulic-engineering experience applied to condensate drainage and pumping problems. Designs jet pumps, piping, and knows steam specialties, pumps. Desires position as engineering assistant. Me-376.

MANUFACTURING-PLANT MANAGER OR SUPERINTENDENT, organizer, coordinator, thoroughly conversant all plant activities, including costs determination and analyses. Background of industrial engineering experiences Me-377.

[1] All men listed hold some form of A.S.M.E. membership.

MECHANICAL ENGINEERING GRADUATE, June, 1939, age 27, married. Some drafting, machine-design, and mechanical experience. Desires position leading to design, or in maintenance and repair, or assistant supervisory capacity. Me-364-102-Chicago.

MECHANICAL-ELECTRICAL ENGINEER, graduate, professional license. Sixteen years' executive experience plant layout, maintenance, production, cost-saving manufacturing field. Desires connection executive or sales-engineering building products, industrial equipment, or control. Me-365.

FACTORY MANAGER OR SUPERINTENDENT. Practical management and engineering background with broad diversified manufacturing experience. Thorough knowledge of modern production methods; materials; equipment; costs; plant upkeep; organization and labor relations. Me-366.

MECHANICAL-METALLURGICAL ENGINEER, 26, single, Stevens graduate; 20 months' extensive and varied training course with prominent company; 2 years' broad metallurgical application. Now employed, desires connection affording chance for greater progress. Me-367.

### POSITIONS AVAILABLE

PRODUCTION MANAGER, graduate mechanical engineer. Must have considerable electrical experience, and should know as much, or more, than his workmen about every machine in the plant. Location, Middle West. Y-4563C.

DRAFTSMAN for steam turbines. This experience is essential. Location, New York State. Y-4567.

PRODUCTION ENGINEER for plant printing sanitary hoods for milk bottles. Must have experience in turning out articles at very rapid rate. Printing experience is essential. Location, New York, N. Y. Y-4580.

SALES REPRESENTATIVES for company manufacturing abrasive products and grinding machinery. Men with sales ability and experience in grinding operations would qualify for work. However, experience in grinding operations not essential; knowledge of production highly desirable. Apply by letter giving full particulars as to age, experience, etc. Territories, Chicago and St. Louis districts. Y-4586C.

AERONAUTICAL ENGINEERS, with five or more years' aircraft-engineering experience, to handle completely design and supervision of engineering on the following units: Fuselage, wing and center section, landing gear and hydraulics, equipment, power plant and fuel system, controls, empennage, electrical and radio, stress, and checking. Work will be on four-engine all-metal transport airplanes. Apply by letter enclosing recent photograph. Location, West. Y-4587S.

TIME-STUDY ENGINEER, 28–35, graduate mechanical engineer. Must be thoroughly trained in time-study procedure; rubber-shop experience would be desirable. Company will consider man with special training in machine-shop work. Must have good personality, and be able to get along with labor. Salary, $225–$250 a month. Location, Middle West. Y-4597C.

DRAFTSMAN with experience in steel-mill machinery and who is competent to design and

(*A.S.M.E. News continued on page 776*)

# STATEMENT OF POLICY

The world is entering a crisis, the result of which no one can foresee. Other wars have brought inflation, followed by unemployment and depression after peace was achieved. America's experience in the World War illustrates this fact.

Much of this post-war trouble would have been eliminated by a more foresighted price policy on the part of manufacturers and distributors. Price inflation by the seller when he had a dominant position resulted inevitably in reaction with deflation, depression and suffering. Many of those price increases were not warranted.

Before such an inflationary cycle of prices is again started, we publicly pledge ourselves, as far as possible, to maintain present prices.

Further, if the materials we buy are increased in price, or the cost of labor is increased, then we pledge ourselves to raise selling prices no more than the bare increase in cost of raw materials and labor going into our products.

Further, we pledge ourselves to pass on to our customers the reduction in cost made possible by better manufacturing methods, wider distribution and technical advances in production.

THE LINCOLN ELECTRIC COMPANY

Cleveland, Ohio
October 2, 1939

J. F. Lincoln
President